RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

EDITOR
LEON J. MENVILLE, M.D.

ASSOCIATE EDITOR
HOWARD P. DOUB, M.D.

VOLUME 24
January to June, 1935

OWNED AND PUBLISHED BY
THE RADIOLOGICAL SOCIETY OF NORTH AMERICA
AS ITS OFFICIAL JOURNAL

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PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

VOL. 24 JANUARY, 1935 NO. 1

INCREASED IRRITABILITY OF THE GASTRO-INTESTINAL TRACT

A DISCUSSION OF DISTURBED PHYSIOLOGY[1]

By B. A. RHINEHART, A.B., M.D., *Little Rock, Arkansas*

WITH the increasing perfection of roentgenologic methods of examining the gastro-intestinal tract, it has become well established that a large number of patients suffering from gastro-intestinal disorders are not the victims of organic lesions. As a matter of fact, some authors go so far as to say that, of all patients with gastro-intestinal diseases, those manifesting functional disorders are in the majority. The most common of the functional disorders is a condition of increased irritability of the muscles, and perhaps of the nerves, along the alimentary canal, resulting in demonstrable increased activities of dynamic, static, and postural nature. The term "increased irritability" is used for want of a standard diagnostic name. None of the many synonyms, such as nervous indigestion, simple colitis, mucous colitis, mucomembranous colitis, etc., has been generally accepted.

There is a growing opinion that the increased alimentary irritability is only part of a generalized physiologic disturbance. This may or may not be associated with demonstrable organic disease. A detailed survey of the symptoms given by those patients in whom gastro-intestinal examinations show hypermotility, localized and generalized spasticity with stasis, but no signs of organic disease, will disclose many symptoms of increased muscular activity in other parts of the body. A complete history and roentgen examination of all patients with gastro-intestinal complaints will show that a third or more of them have a combination of organic lesions and generalized increased neuromuscular activity.

However, because an increased muscular activity of the alimentary canal may arise from simple stasis in the appendix or from other local points of heightened gradient, even the most careful questioning and a thorough appreciation of the interpretation of the various muscular spasms and cramps will not supplant a roentgen examination. Conversely, we may not expect to be able to find typical roentgen findings in all patients with abnormal irritability. In such cases the deciding evidence lies in the information derived from the history, and from tests for increased irritability of the neuromuscular system.

Increased activity of any of the muscles of the body may be present but, as a general rule, those muscles which are used most will be the first to cramp. Needless to say, it is not necessary for patients to have gastro-intestinal disorders with functional hyperactivity of other muscles. For example, paroxysmal tachycardia, bronchospasm, vasomotor spasm, or eclampsia are not always accompanied by gastro-intestinal spasm.

Rankin, Bargen, Buie, and Douthwaite

[1] Read before the Radiological Society of North America, at the Twentieth Annual Meeting, Memphis, Tenn., Dec. 3–7, 1934.

have pointed out that most of the subjects of increased irritability of the gastro-intestinal muscles lead sedentary lives. Therefore, we may expect those muscles which are not skeletal to be the first involved. Included in this type are the gastro-intestinal muscles, the cardiac muscle, and the other muscles receiving their nerve supply from the autonomic system, such as the bronchial, arterial, uterine, bladder, and ureteral. The first skeletal muscles to be involved are usually those of posture, the most active groups of postural muscles being those in the neck and in the lumbar region.

The symptoms of extra-abdominal muscular irritability are as common as, and often more distressful than, those arising from the alimentary canal. Extra-alimentary muscular irritability is manifested in such frequent symptoms as breathlessness, smothering and choking, particularly at night, irregular or abnormally rapid heart action, uterine cramps, polyuria, paresthesias or anesthesias of the extremities, twitchings of the smaller voluntary muscles, and aching in the neck or lower back. In addition to the symptoms of increased muscular excitability, there are many instances of neuroses or dysfunction of the nervous tissues. From the combination of these two groups of manifestations, the term "nervous indigestion" has arisen. In the group of symptoms arising from the increased irritability of the nervous system are such reactions as reasonless laughing and crying, insomnia, anger, worry, restlessness, fear, slight fever, lowered basal metabolism, increased secretions, and increased reflexes. The nervous and muscular symptoms subside simultaneously, and there is evidence, which will be given later, that they are caused by the same chemical changes.

The symptoms of increased gastro-intestinal irritability are well known to roentgenologists and need not be repeated. However, one of the first symptoms to appear which has not received the attention it merits, is a feeling of distention or bloating in the upper abdomen, occurring after a few swallows of food or water. Although stomachs vary greatly in size, I believe that I have observed a contraction of the antrum and a small fold of mucosa on the lesser curvature associated with this symptom. In the light of the knowledge of gastric anatomy and physiology derived from the writings of Cole, Alvarez, and Klein, this contracture seems to be a systole of the antrum, corresponding to systole of the cardiac ventricles and to the same type of contraction which occurs transiently in the course of normal gastric peristalsis. It seems probable that from this abnormal systole arises the pain so often mistaken for ulcer, although it comes sooner after meals and later at night.

So many excellent descriptions of the roentgenologic findings in patients with increased irritability have been given that a review of them is considered unnecessary. The roentgen-ray findings emphasize the beliefs of Pottenger and Charles Bolton that pain from the hollow abdominal viscera is due to increased muscular tension. The increased tension seems to be chiefly in the muscularis propria. I have been unable to find a description of increased tension in the muscularis mucosæ. Although the function of the sphincteric muscle is tension, an increased postural activity of the sphincters of the colon may cause pain.

An increase in the tension of the muscles of the alimentary canal, sufficient to produce pain, may be caused by an abnormal reaction to a normal stimulus, or by an abnormal stimulus. Abnormal reaction to a normal stimulation occurs in hypersensitive states. Abnormal stimuli caused by local lesions, bulky diet, and irritating therapeutic measures, do not fall within the scope of this discussion except in their relationship to an irritative condition. In patients who have an excessive muscular reaction, it is important to recognize lesions which give rise to steepened gradient: tumors, infections, ulcerations, obstructions, and stasis will do so. Stasis in a non-infected appendix may cause painful

tension in the entire colon. Recently I observed such a case after an abnormal neuromuscular irritability had been corrected.

Unfortunately, roentgenology will not show those changes described by McCarrison as being due to deficiencies in the food vitamins, unless ulcerative colitis and diverticulosis are advanced conditions of deficiency disorders. However, it is probable that degenerative changes often accompany increased irritability.

Although the roentgen findings in neuromuscular irritability of the alimentary canal are well known and the general manifestations can be elicited by careful questioning, possible etiologic factors are not so well understood. Usually etiology is dismissed with the statement that it is a nervous condition. However, researches on the stability of the nervous system have disclosed that the reason for increased irritability may be found in a chemical disturbance of the perfusion solution which bathes these spastic muscles and hyperirritable nerves. The researches show that it is usually the calcium part of the sodium-potassium-calcium ratio that is at fault, and that correction of calcium metabolism re-establishes the normal ratio.

The perfusion solution is very important to the physiologist, working with a piece of muscle in his laboratory: it must be just as important *in vivo*. The physiologist controls the proportion of salts in his Locke's and Ringer's solutions by weight. The same method is not feasible for the control of the same salts in the circulating blood and tissue fluids.

During the early part of the last decade, it was discovered that Nature's method of controlling the inorganic salts in the body is by means of sunlight through the effect of ultra-violet radiation. The effect of the visible and infra-red rays is not yet known. Soon after the discovery of Vitamin D, the parathyroid glands were found to be the guardians of the storehouses of minerals in the bones. In 1925, Collip reported the isolation of the active principle of these glands. To-day, there is more known about Vitamin D and its physiologic activities than about any other vitamin, yet the practical application of this knowledge has not been fully utilized. Several investigators have shown that a blood calcium determination is not sufficient to ascertain the state of calcium metabolism, and that the quantity of calcium in the circulating blood does not denote whether the calcium stream is toward the bones or away from them. Manifestly, depletion of the storehouse is undesirable and will eventually result in disaster.

In addition to correct methods of control of the inorganic salts in the blood stream, constant sources of supply are essential. Sherman says that a larger proportion of ordinary dietaries are deficient in calcium than in any other one chemical element. He gives the human requirement of calcium as nearly a gram each day. This quantity can be satisfactorily obtained only from milk and cheese. In a New York hospital, Bernheim found two patients out of 4,000 whose diet gave an adequate supply of calcium. These two patients were in the hospital as a result of injury and not disease. Bernheim believes that the importance of calcium in human nutrition and health seems far greater than is commonly realized. Calcium constantly is being excreted from the body in the urine and feces. There is an especially heavy drain on women because of menstruation, pregnancies, and lactation. This may be the cause for the greater number of digestive disturbances in women than in men.

Some of the points on mineral metabolism brought forth by J. B. Orr, in his Presidential Address before Section M of the British Association for the Advancement of Science, in 1925, are as follows:

1. From 10 to 25 per cent of living matter consists of organic compounds from which the colloidal material of the protoplasm is formed. The remaining 75 to 90 per cent consist of water and inorganic salts. The true basis of protoplasm is the saline solution which forms from 75 to 90 per cent of its bulk and which still re-

sembles the sea water from which it originated.

2. In a real sense, protoplasmic activity is regulated by the action of the mineral elements in solution in the protoplasm or attached to its colloids. Thus, in the contraction of muscle, though the ultimate source of energy is the oxidation of organic compounds, the initiation of the process, the mechanism by which it is carried through, and the factors by which it is controlled, depend on the action of the ions and salts present, which involve changes in osmotic pressure and other physical forces.

3. Mineral metabolism is more important than the metabolism of carbohydrates, fats, and proteins, for animals will die sooner from privation of minerals than from complete starvation.

4. The results of experiments with unicellular organisms and with isolated organs, such as the perfused heart, have shown that slight alterations of any of the inorganic ions may accelerate, retard, or even reverse processes being carried out by means of the colloidal mechanism.

5. In the animal body these changes in the concentration of the inorganic ions can be correlated with changes in the functions of the organs. Thus, all the organs regulated by the central nervous system depend for the integrity of their functions upon the maintenance of definite ratios of calcium, potassium, and sodium in the fluids within the nerve tissues. Changes in the relative proportions of these are accompanied by alteration in the excitability of nerve and in the irritability of muscle.

6. Forster's experiments on the effects of feeding a diet from which mineral salts had been removed showed profound disturbances caused by relatively small losses of inorganic salts from the system. Signs of disturbance of the digestive organs appeared early. They were soon accompanied by increased excitability and weakness of the neuromuscular system. The central nervous system was also affected, as was shown by the occurrence of convulsions and periods of drowsiness.

7. The hyperexcitability which occurs in calcium deficiency can be explained by the influence of the ion concerned on the colloids of the tissues or on the permeability of the membranes.

8. It has been shown recently that the supply of minerals in the food of the mother may have a profound influence on the vitality of the young at birth and for some time after, even when there may be no obvious effect on the mother.

9. Some attention has recently been devoted to the question of an increased susceptibility to certain infectious diseases in cases of malnutrition due to deficiencies of minerals. Orr noted in feeding experiments that the mortality from intercurrent infections in the groups fed on diets which are ill-balanced or deficient in mineral matter is greater than in the other groups. meigs has noted a similar increased incidence of diseases in cows fed on diets deficient in calcium.

10. At the Rowett Institute, Orr found that when animals are subjected to the influence of ultra-violet rays the amounts of calcium and phosphorus absorbed from the intestine tend to be increased.

11. By his discussion, Orr attempted to establish the fact that "the mineral elements play such an important part in the physiologic processes of the animal body that serious pathologic conditions develop when the supply in the food does not meet the requirements of the animals."

Following the ideas of Hess and other writers, it is apparent that correct mineral metabolism depends on intake, absorption, assimilation, balance, and conversion. Part of this metabolism is controlled by the effects of sunshine and the parathryoid hormone. However, neither of these will supplant intake and absorption. Time does not permit an elucidation of the various factors controlling absorption of food or medicinal calcium. However, the antirachitic or calcium and phosphorus-controlling vitamin cannot be obtained in sufficient quantities from food.

The lesson derived from the foregoing investigations is that the increased irritability of nerve and the excitability of muscle such as we encounter in gastro-intestinal diseases appears to be the same as that originating from deficiencies of calcium and Vitamin D, particularly since the highest incidence of gastro-intestinal disturbances, along with that of rickets, is in the urban population.

It is fortunate that we are able to recognize increased irritability by means of a delicate and reliable test. The hypersensitive state can be diagnosed by using the galvanic current to stimulate the peripheral nerves. It gives rise to a reaction known as Erb's phenomenon. Hess says that this electrical test is the final criterion in regard to the diagnosis of latent tetany. Occasionally, however, the test is negative and the diagnosis depends on therapeutic results.

Erb's phenomenon is elicited by shocking the median nerve with a small galvanic current. A large positive electrode, wet with salt solution, is placed over the upper arm or back and a small negative electrode over the median nerve at the wrist. Because results are obtained with a smaller shock, the cathode closure current is the one generally used. The smallest amount of current that will give a visible reaction of any of the muscles of the hand is determined. Using 45 volts, a contraction with from 5 to 7 milliamperes of current is considered normal. Because of discomfort to the patient, Winklestein does not use over 3 milliamperes. If a contraction is obtained with less than 3 milliamperes, latent tetany is present. The use of the electrical stimulation of nerves in all patients with gastro-intestinal diseases results in a surprisingly large number of abnormal reactions.

The two mechanical tests for tetany, Chvostek's and Trousseau's, are not so accurate nor as dependable as the electrical test. It appears unfair to attribute all of the clinical manifestations of increased gastro-intestinal irritability to errors in mineral metabolism. In other words, a close parallelism between the chemical deficiency and the symptomatology does not always exist. Unnatural stimulation increases the severity of the abnormal reactions. According to Hurst, the secretion of excess mucus in the colon is a response to chemical and mechanical irritations to the already abnormally irritable sympathetic nerves. The most common of these irritants are physics, enemas, douches, suppositories, irrigations, and undigested food residues. Aggravation of the irritability occurs with such methods of excessive stimulation.

SUMMARY

Uncomplicated increased gastro-intestinal irritability, commonly known as nervous indigestion, simple colitis, mucous colitis, spasticity of the colon, etc., is a part of a general neuromuscular disorder. This condition appears to be the result of defects in the perfusion solution which bathes the muscles, nerves, brain, and spinal cord. Researches and investigations show that this deficiency is chiefly in the metabolism of calcium. The errors in calcium metabolism are due to insufficient supplies of calcium and Vitamin D, resulting in latent tetany. There are three important diagnostic measures: history, roentgen-ray examination, and tests for tetany.

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PROTRACTED EXTERNAL IRRADIATION IN THE TREATMENT OF NEOPLASMS OF THE MOUTH AND THROAT[1]

A COMPARISON OF X-RAYS, 5-GRAM RADIUM PACK, AND 100-MILLIGRAM RADIUM PACK

By MILTON FRIEDMAN, M.D., Research Fellow and Assistant Visiting Radiation Therapist, *and* RIEVA ROSH, M.D., Associate Visiting Radiation Therapist, Bellevue Hostpital, *New York City*

From the Radiation Therapy Service, Bellevue Hospital, New York City, Dr. Ira I. Kaplan, Director

PURPOSE OF THE WORK

THIS presentation is a two-year clinical study[2] of the effect of protracted external irradiation upon neoplasms of the upper respiratory tract. It undertakes the following:

(1) To compare the gamma rays produced by high voltage x-rays with those produced by radium from a purely clinical standpoint;

(2) To ascertain the optimum number of days for the administration of radiation;

(3) To ascertain the optimum number of hours per day during which rays may be administered;

(4) To define the indications for interstitial radiation.

TECHNICS

The three following technics were employed (Table I):

1. *X-rays (Coutard Technic)*

200 K.V.; 4 ma.; 2 mm. Cu and 1 mm. Al filtration; 60 cm. distance; 10 × 15 cm. portal (150 sq. cm.).

The duration of treatments was from 18 to 28 days.

TABLE I.—TECHNICS EMPLOYED

	X-rays	Large radium pack	Small radium pack
	200 K.V.; 4 ma.	5,000 mg.	100 mg.
Filtration	2 mm. Cu and 1 mm. Al	0.5 mm. Pt and 5 mm. Pb (6 mm. Pb equivalent)	2.5 mm. Pt (5 mm. Pb equivalent)
Distance	60 cm.	6 cm.	6 cm.
Portal	10 × 15 cm. (150 sq. cm.)	8 × 10 cm. (80 sq. cm.)	7 × 9 cm. (63 sq. cm.)
	Dose		
Daily dose	200 to 250 r to each of two portals	5,000 mg.-hr. to one alternate area each day. This averages 2,500 mg.-hr. to each area daily	2,400 mg.-hr. to each of two portals
Duration	18 to 26 days	21 to 28 days	18 to 23 days
Total dose	3,400 to 4,400 r (equal to from 3.75 to 5 S.E.D.) to each portal Measured with back-scattering	50,000 to 60,000 mg.-hr. (equal to from 3 to 3.5 S.E. D.) to each area	40,000 to 45,000 mg.-hr. (equal to from 2.25 to 2.75 S.E.D.) to each area

The time of each treatment was 45 minutes to produce 200 r. Two areas were treated each day, one in the morning and one in the afternoon.

The total dose was from 3,400 to 4,400 r to each of the two portals (measured with back-scattering). This is equivalent to from three and three-fourths to five skin erythema doses.

2. *Five-gram radium pack*

6 mm. Pb filtration; 6 cm. distance; 8 × 10 cm. portal (80 sq. cm.).

The daily dose was 5,000 milligram-

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[1] Read before the Fourth International Congress of Radiology, Zürich, 1934.

[2] This study has been made possible through the grant of William Warner & Co., and the Schering and Glatz Research Fellowship.

hours. Only one area was treated each day, this being equivalent to 30 per cent skin of a erythema dose.

The time was from 28 to 30 days.

The total dose was 50,000 mg.-hr. (3 S.E.D.) to 60,000 mg.-hr. (3.5 S.E. D.) to each of two areas.

The grand total was 100,000 mg.-hr. to 120,000 mg.-hr.

3. *Small 100-milligram radium pack*

2.5 mm. Pt filtration; 6 cm. distance; 7 × 9 cm. portal (63 sq. cm.).

The daily dose was 2,400 mg.-hr. to one or both sides of the neck, depending upon the use of one or two packs.

The time was from 18 to 25 days.

The total dose was from 43,000 to 60,000 mg.-hr. to each area.

The x-rays were administered according to the Coutard technic. The r were measured so as to include back-scattering. The portal was kept constant in size in all treatments in order to maintain a constant technic for more accurate comparison, even though efficiency was occasionally sacrificed.

A comparative group of cases, but not included in this series, was treated with x-rays filtered with 0.5 mm. copper, giving the same number of r per day, all other factors being constant except the time duration of each treatment, which was shorter. It was found that rays of this quality produced an epithelitis and epidermitis, more intense and appearing earlier than that produced by rays filtered through 2 mm. copper. This excessive reaction diminished the total amount that could be administered to the patient. As we shall see later, the largest quantity that was administered to any one patient, when 0.5 mm. copper filter was used, was 2,750 r to each portal (measured with back-scattering), whereas, with the 2 mm. copper filter, giving the same number of r per day, a total dose of 4,400 r was safely given (Table II).

The five-gram pack technic was designed to reproduce as closely as possible, in the same time of administration of incident radiation as the x-rays, equivalent biologic reactions of epithelitis and epidermitis, or, in other words, the same biologic dose. It is appreciated that the radium pack portal measured 80 sq. cm., the most efficient size that would include the local lesion and the regional lymph nodes in the largest majority of cases, as compared with the 150 sq. cm. portal for the x-rays. Furthermore, the focal skin distance of the radium pack is 6 cm. as compared with 60 cm. for the x-rays. Expediency dictated these discrepancies. Consequently the depth dose of the radium pack is much smaller, being about one-third that of the heavily filtered x-rays. When the 5-

TABLE II.—REACTIONS FROM X-RAYS (200 K.V.)

Number of treatment days	Total Dose in r (∂ scat)	Epithelitis				Epidermitis			
		Begin	End	No. of days	Intensity	Begin	End	No. of days	Intensity
0.5 mm. Copper									
16	5,150	10	30	20	1½°	13	33	20	2°
2 mm. Copper									
22	8,400	13	39	26	1¾°	17	42	25	2°

TABLE III.—"DESTRUCTIVE PHASE" OR "OPTIMUM TIME DURATION" FOR DIFFERENT WAVE LENGTHS

	X-rays	X-rays	Radium Gamma Rays
X-ray quality	200 K.V. 0.5 mm. Cu and 1 mm. Al w.l.—0.16 Å.U. h.v.l.—0.92 mm. Cu	200 K.V. 2 mm. Cu and 1 mm. Al w.l.—0.11 Å.U. h.v.l.—1.8 mm. Cu	6 mm. Pb filter w.l.—0.01 + Å.U. h.v.l.—12.5 mm. Pb
Optimum time duration	16 to 18 days	21 to 25 days	28 to 30 days

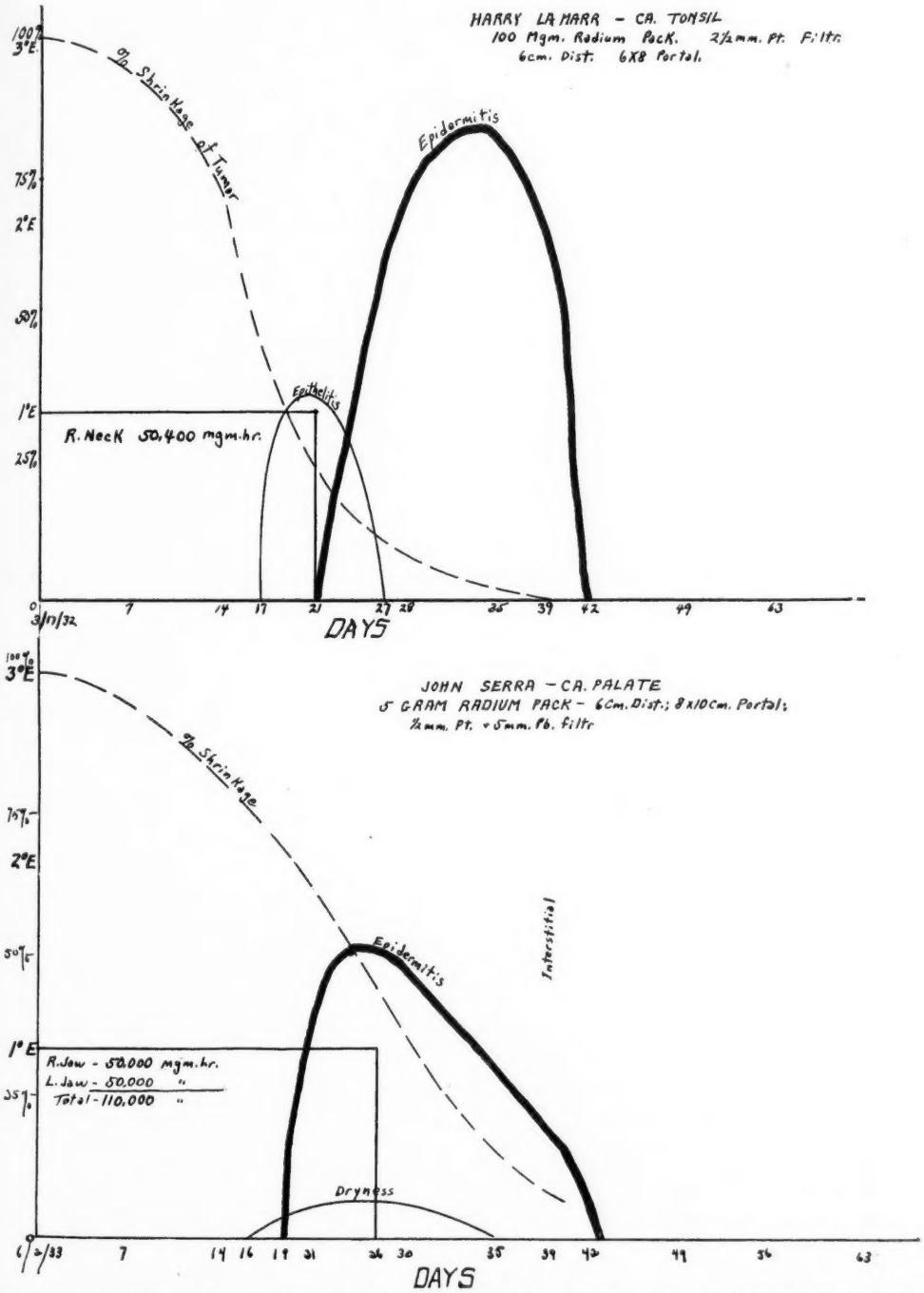

Fig. 1. Graphic records of reactions. *Above:* tumor shrank 50 per cent in 16 days, and completely as a result of the external radiation alone. *Below:* tumor required $3\frac{1}{2}$ weeks to shrink 50 per cent. Supplementary interstitial radiation was given as soon as mouth was comfortable, and while the shrinkage was on the down-grade, and required only a small dose.

gram pack was applied to the skin in one sitting, lasting three and one-half hours, the incident dose of 17,500 mg.-hr. produced a threshold erythema. Each daily treatment lasted one hour, giving a dose of 5,000 mg.-hr. (30 per cent S.E.D.) to only one of the two portals each day. The portals being alternated on successive days, this gave an average of 2,500 mg.-hr. a day to each portal as compared with the 2,400 mg.-hr. given to each portal with the small 100-mg. pack.

The small pack technic duplicated all the factors of the five-gram pack except the quantity of radium, which was 100 milligrams for each pack. In order to deliver the same daily dose as the five-gram pack, the exposure was carried out for 24 hours a day. The radium tubes were placed within a slightly smaller portal in order to compensate for the increased field and consequently increased back-scattering in the tissue depths because of the unconfined beam. In the large pack, the beam was sharply defined by lead walls.

For the sake of constancy throughout the entire study, only two lateral portals were employed in every case, with occasional exceptions in cases in which the extensive involvement of the cervical nodes would not fit within the area of the portal. These cases were not included in the series. After experimenting with many devices, the small pack, which is best held in place by bandage rather than fixation apparatus, was finally made up of a small cardboard box, 5 cm. high, with an additional 1.5 cm. of rubber sponge at the bottom to accommodate itself to the irregularities of the lobe of the ear and the angle of the jaw, thus avoiding pressure necrosis. The rubber sponge is compressed down to a thickness of 1 cm., making a final skin-radium distance of 6 centimeters. Undoubtedly, the slight pressure ischemia from the weight of the pack tends somewhat to diminish the epidermitis. The shoulders are protected with lead plates, 1 cm. thick. The pack is removed for a few hours every five days in order to give the patient a rest, and to clean the skin. The preferable time for treatment for rays of this quality is 28 days, but this can seldom be carried out because the epidermitis will not permit the continued pressure of the pack after the twenty-third day.

During the course of the treatment, all patients are continuously observed and the intensity of the reactions of the skin and mucosa as well as the rate of shrinkage of the tumor are graphically recorded. These recordings are made thrice weekly, and all deductions reported herein are drawn from these graphs (Figs. 1 and 1-*A*).

TIME DURATION OF TREATMENTS

When a full erythema dose of radiation is administered in one treatment, an erythema appears, reaches its peak, and then subsides. The "destructive phase" of this phenomenon is in progress from the time the treatment is given to the peak of the erythema. Following this, the "healing phase" ensues. This is accompanied by fibrosis, repair, and increased radioresistance. Each ray quality has its own characteristic time for the duration of the destructive phase (Table III).

(1) X-rays, which have an effective wave length of 0.16 Å.U. and a half value layer of 0.92 mm. Cu (200 K.V.; 0.5 mm. Cu filtration), when given in a single dose, produce an erythema which reaches its peak in approximately from 16 to 18 days. When these rays are administered at the same rate of 200 r per day as those filtered with 2 mm. Cu, the reaction becomes so intense by the sixteenth day that no further treatment can be given. As mentioned before, this curtails the total quantity that can be given to only 2,750 r with this longer wave length ray, as compared with 4,400 r to each portal with the shorter wave length ray. Consequently, we postulate from 16 to 18 days as the optimum time duration for the administration of protracted external irradiation with rays of this quality.

(2) X-rays produced according to the Coutard technic (200 K.V.; 2 mm. Cu filtration) with an effective wave length of 0.11 Å.U., and a half value layer of 1.8

mm. Cu, have a "destructive phase" or an "optimum time duration" of approximately 21 to 23 days. This is additionally verified by the fact that, if treatments are prolonged too far beyond this time, the reactions are less intense. This indicates a diminished effect of the rays upon the biologic target, *i.e.*, skin, mucosa, and tumor. The epithelitis may even subside and heal though *treatments are being administered currently.*

Our experiences confirm those of Coutard in permitting the conclusion that the most effective type of protracted external radiation is that which will produce an epithelitis and an epidermitis of second degree intensity, wherein the epithelitis appears from 5 to 7 days before the epidermitis, and terminates in the same order. The reactions should be overlapping. Coutard believes they should be consecutive.

Any radiation that is administered later than the customary 3 or 4 weeks is directed at a tissue which is now rendered capable of not only resisting the destructive effect of the rays, but also of undergoing reparative fibrosis while under bombardment. The acquired radioresistance of the cells at this stage (*i.e.*, about one month after the onset of the treatment) is enormous. Grossly, the previous soft mass of the tumor which offered no resistance to puncture with a radium needle or other instrument is now converted into a tough, hard mass which is difficult to penetrate with a radium needle. The few remaining cells now locked in a dense fibrous stroma can easily resist any type of external radiation. Therefore, increasing the total dose much above 8,800 r when treatments have unavoidably been extended

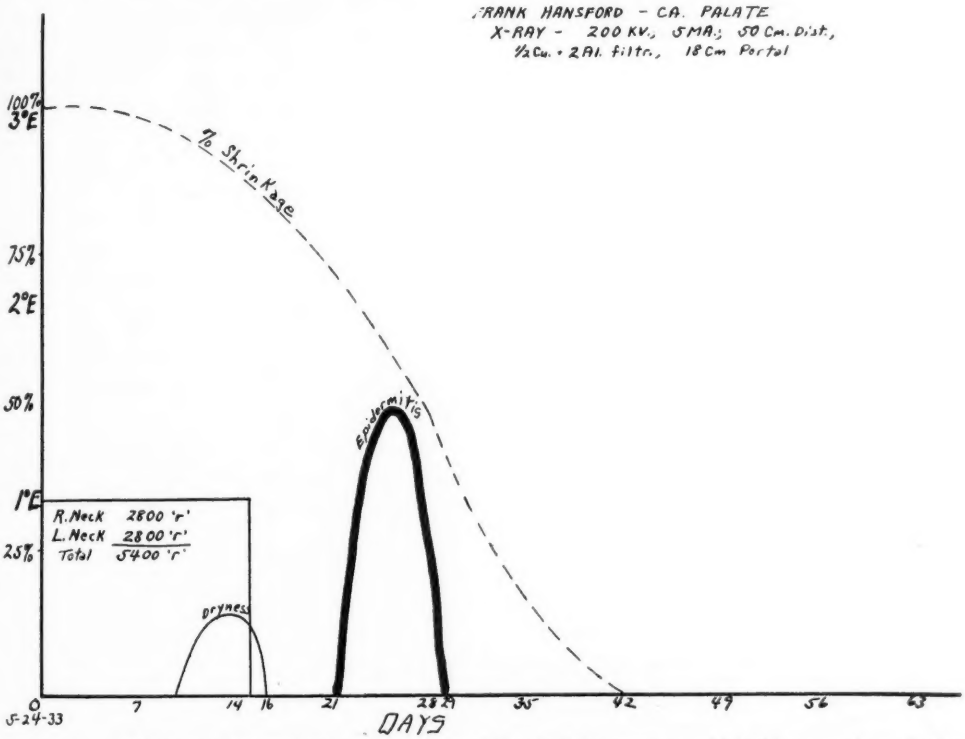

Fig. 1-*A*. Small dose of external radiation as evidenced by the light reactions, which did not overlap. Lesion shrank slower than 50 per cent in 14 days, and even though there was complete primary regression, it recurred several months later, and required a large dose of interstitial radiation which produced a severe, prolonged reaction.

beyond 21 days does not seem to influence the response of the tumor.

If the duration of the treatments is too short, there results an increase in the severity of the epithelitis and epidermitis, with a prolongation and intensification of these reactions. This necessitates a curtailment of the total dose administered.

(3) Radium gamma rays, of 0.01 Å.U. effective wave length, and with a half value layer of 12.5 mm. lead, at 6 cm. distance will produce a threshold erythema with a dose of 17,500 mg.-hr. The latent period varies from 4 to 6 weeks. The peak of the erythema may not be reached for from 6 to 8 weeks. This inconstancy renders the observation of the threshold erythema less reliable in the determination of the "optimum time duration" for this quality ray, than the observance of the appearance of the reactions during the course of the treatments. It is found that the "destructive phase" for the gamma ray lasts from 28 to 30 days, after which time the tumor is so altered as to become very markedly resistant to further influence. Slight variations in the number of days of treatment cause definite changes in the responses of the patient and his tumor.

It is acknowledged that neoplasms of different degrees of malignancy have characteristic rhythms of growth and optimum times of response to radiation. It appears however, that this factor of growth rhythm may be equalled in importance by the temporal rate of effectiveness of the ray quality employed.

INTERSTITIAL RADIATION

In this series are included all types of carcinomas of the mouth and throat, of varying degrees of malignancy. Many of them are not completely destroyed by the external irradiation, and require interstitial irradiation.

Following protracted external irradiation, the tumor bed has been so modified by the resultant increased fibrosis that it cannot tolerate the interstitial radiation as well as non-irradiated tissue can. The subsequent radium reactions are prolonged, painful, and frequently never heal spontaneously. Furthermore, any bone that comes within range of the interstitial radiation rapidly breaks down, and becomes the seat of prolonged osteomyelitis.

We have observed in this series that if a lesion shrinks 50 per cent in from 14 to 16 days after the onset of the treatment, it will usually disappear completely as a result of the external radiation alone. If it is not so radiosensitive as this, then its selective sensitivity is too close to normal tissue to permit protracted external irridiation alone to be effective. There will be a residuum or a recurrence for which interstitial radiation will have to be delivered at some time or other. Occasionally a lesion which shrinks at the rate of less than 50 per cent in from 14 to 16 days will eventually disappear completely just from external irradiation alone, but, in our series, every case of this nature eventually recurred, sometimes one year later (Figs. 1 and 1-*A*).

If we wait until the external radiation has been fully delivered and the reactions from it subside (*i.e.*, from five to six weeks) before inserting needles or seeds, the tumor bed will have been so modified by fibrosis that the resultant radium reaction will be considerably prolonged and debilitating. Furthermore, a larger dose of interstitial radiation than usual will be required because the desmoplasia has increased the radioresistance.

Therefore, at the end of from 14 to 16 days of protracted external radiation, every case is carefully analyzed. If the shrinkage is less than 50 per cent, the external radiation is abruptly terminated so as not to modify the tumor bed any further, and interstitial radiation administered as soon as the comfort of the mouth permits. Since the tumor is still actively regressing, and the fibrosis of repair has not yet set in to any great extent, only a small dose of interstitial radiation is required to destroy the remaining tumor. The resultant reaction is gratefully tolerated by the patient, the tumor bed, and the

adjacent bones. However, if we wait longer than from five to six weeks for the interstitial radiation, a much larger dose will have to be given to the same volume of tissue, which is now more radioresistant and less tolerant.

Occasionally the residual tumor is still very extensive and a large dose of interstitial radiation must be given, so that the anticipated reaction will be severe. Or else, after a full course of external irradiation, the tumor does not shrink as expected, and interstitial radiation must be given. In this event, two weeks after the needle insertion, when the severity of the reaction is commencing to subside, extensive débridement is performed by electrosurgery. This hastens the eventual healing and shortens the period of debility due to absorption of necrotic material.

This operation is preceded, wherever possible, by preliminary regional nerve block with alcohol injections, which serves not only to provide anesthesia for the operation, but also to anticipate and mollify the pain from the subsequent osteitis and osteomyelitis.

This problem of interstitial radiation is important because it is our general impression that exclusive protracted external irradiation seldom entirely eradicates the more common radioresistant carcinomas or the advanced lesions. Very often, there remain impalpable residual cancer cells locked up in fibrous tissue for several years only to break through this wall and grow again or produce metastases in unusual sites. This residual tissue must be destroyed by interstitial radiation, electrocoagulation, or both.

DURATION OF DAILY TREATMENT

Ideal irradiation is that which is administered continuously for 24 hours a day over the longest effective time period. This cannot be done with x-rays, so, therefore, a compromise is made whereby the patient is exposed to x-rays for 1.5 hours a day, and permitted to rest during the remaining 22.5 hours. To increase the efficiency of this irradiation, one must decrease the rest period. The small 100-milligram pack accomplishes this by giving in 24 hours approximately the same dose that the five-gram pack gives in one hour, *i.e.*, 2,400 milligram-hours per area.

A comparison of the reactions (Table IV) indicates that the double small pack, with a dose of 43,000 milligram-hours to each area gives a slightly less intense epithelitis, but a more intense epidermitis than the large pack, giving a dose of 55,000 milligram-hours to each of two areas over a similar period of time.

In Table V, we note that a five-gram pack, giving a dose of 56,000 mg.-hr. to each of two areas (line 6), when compared with a single small pack giving the same dose in the same period of time to only one area (line 12), will produce practically the same intensity of epithelitis and epidermitis, though of a longer duration. When comparing the doses of threshold

TABLE IV.—SUMMARIZATION OF REACTIONS PRODUCED BY DIFFERENT TECHNICS

The upper box containing the three small pack notations demonstrates the regularity and constancy of the increase in intensity and duration of the reactions with the increase in dose. Neither of the other two technics were as consistent. See text for explanation of lower two rows.

No. treatment days	Dose in mg.-hr.	Epithelitis				Epidermitis			
		Begin	End	No. of days	Intensity	Begin	End	No. of days	Intensity
Single Small Pack									
21	50,000	14	25	11	1½°	19	42	23	2¼°
23	55,000	17	29	12	2°	23	53	30	2°
25	59,500	16	38	22	2°	24	46	21	2°
Double Small Pack									
19	43,000	11	28	17	1½°	16	38	22	2½°
5-Gram Pack (short duration) Two Areas									
21	55,000	11	33	22	2°	14	35	21	1⅓°

effectiveness of these two radium packs (lines 2 and 9), we see that 50,000 mg.-hr. with the single small pack will produce a 1.5 degree epithelitis and a 2.25 degree epidermitis, whereas the large pack, giving the same dose over two areas, will produce only a 0.25 degree epithelitis (dryness) and a 1.5 degree epidermitis.

The relatively small group of 14 cases treated with the small pack permits the formulation of only tentative conclusions as to the effect of continuous irradiation upon the tumor itself as compared with other technics. Nevertheless, we have shown that the small pack, with only 80 per cent of the dose given with the large pack, will produce the same intensity of skin and mucosal reactions, and a slightly superior effect upon the tumor itself.

In terms of the skin erythema units, it requires from 3 to 3.5 S.E.D. of gamma radium rays delivered by the large pack to produce the same reactions and results as 2.25 to 2.75 S.E.D. delivered with the small pack. The ratio of the time factor of each treatment for the two packs is 1 as compared with 24 hours a day. When expressed in terms of clinical effectiveness, the ratio is 4:5, or, in other words, the small pack will produce the same degree of biologic effectiveness as the large pack with only 80 per cent of the dose.

When this law is interpreted in the light of the factors in the Coutard x-ray technic, the use of 20 ma. instead of the usual 4 ma. produces only a slight decrease in the clinical effectiveness. The time required to administer the same dose of 200 r with these two factors to each of two portals daily is 20 minutes with 20 ma. and 1.5 hours with 4 ma. The rest periods with these milliamperages is $23^3/_5$ and $22^1/_2$ hours per day, respectively. These are fairly equivalent times. Though the time duration of each exposure is important, we consider this rest period per day as having greater influence upon the effect of the treatment, because the latter is so

TABLE V.—SUMMARY OF REACTIONS PRODUCED BY DIFFERENT TECHNICS

Each line represents the average of those cases in which the same dose has been given in the same number of days at the same rate. Note that a five-gram pack (line 6), giving a dose of 56,000 mg.-hr. to each of two areas, when compared with a single small pack (line 12), giving the same dose in the same period of time to only one area, produces practically the same intensity of epithelitis and epidermitis, though of longer duration. In line 2, the five-gram pack is administered to two areas to produce a very mild epidermitis and epithelitis. The same dose, when administered by a single small pack to only one area, where there is no benefit of cross-firing, will produce a more intense epidermitis and epithelitis.

Number of treatment days	Dose in mg.-hr.	Epithelitis				Epidermitis				
		Begin	End	No. of days	Intensity	Begin	End	No. of days	Intensity	
5-gram Pack—Two Areas										
8	40,000	7	40	33	$2^1/_2°$	6	40	34	3°	1
25	50,000	17	34	17	$^1/_4°$	18	41	23	$1^1/_2°$	2
25	55,000	10	41	31	$1^3/_4°$	17	45	28	$2^1/_4°$	3
27	60,000	8	39	31	$2^1/_4°$	17	44	27	$2^1/_4°$	4
36	75,000	18	63	45	$2^3/_4°$	18	62	44	$2^1/_4°$	5
Total										
24	56,000	12	43	31	2°	15	46	31	$2^1/_4°$	6
5-gram Pack—One Area										
17	52,000	13	25	12	$1^1/_2°$	16	40	24	$1^1/_2°$	7
Small Pack—Two Areas										
19	43,000	11	28	17	$1^1/_2°$	16	38	22	$2^1/_2°$	8
Small Pack—One Area										
21	50,000	14	25	11	$1^1/_2°$	19	42	23	$2^1/_4°$	9
23	55,000	17	29	12	2°	23	53	30	2° 1	10
25	60,000	16	38	22	2°	24	46	21	2° 1	11
Total										
23	55,000	15	31	16	2−°	22	47	25	2+°	12

very much longer in comparison with the former.

Consequently, when the demands of economy necessitate a sacrifice in any factor, the time factor of each treatment may be reduced with the smallest clinical sacrifice as far as x-rays are concerned. We still acknowledge the great importance of administering one treatment in the morning and one in the evening, thereby splitting in half the time during which the cells are recuperating from the radiation effect.

These deductions are offered presumptively because of the uniformity of the time of appearance of the reactions, their overlapping, and their intensity with the small pack technic. It is impossible for the patient to miss an appointment because of a holiday or week-end, since the pack is always upon him, and the experimental error is much less than with the Coutard and five-gram pack technics.

COMPARISON OF X-RAYS AND RADIUM GAMMA RAYS

When protracted external irradiation with x-rays of 200 K.V. filtered with 2 mm. Cu, and radium gamma rays filtered with 6 mm. lead is administered for the same period of time according to the above technics, and in such quantities as to produce epithelitis and epidermitis of equivalent intensity and duration, there is noted no significant difference in the effect of these two rays upon the tumor.

In terms of the threshold skin erythema dose, utilizing 960 r as the erythema dose for x-rays, and 17,500 mg.-hr. as the erythema dose for the radium gamma rays, it required 4.5 S.E.D. of x-rays to produce the same effect as 3.5 S.E.D. of radium gamma rays delivered by the large pack.

Gamma rays of radium produce a more profound effect upon normal tissues around the tumor than x-rays, rendering them less able to withstand subsequent interstitial radiation. The reactions from the interstitial treatment following radium pack are more severe, and the incidence and severity of the osteitis and osteomyelitis are greater. Finally, as noted before, a single skin erythema dose produced with x-rays appears earlier than the one produced with radium rays, and lasts for a shorter period of time.

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CONCLUSIONS

1. There appears to be very little appreciable difference in the primary effect upon the tumor between x-rays and radium gamma rays as employed in this series.

2. The differences between the two types of rays which do occur are as follows:

(*a*) The erythema from a single skin erythema dose of radium gamma rays appears at a much later time and is more prolonged than that from x-rays.

(*b*) Gamma radium rays produce a more profound effect upon the normal tissues around the tumor, rendering them less well able to tolerate subsequent interstitial radiation.

(*c*) The maximum amount of radiation over the same period of time and causing the same intensity of biologic effect of epidermitis and epithelitis is produced by 3.5 S.E.D. with the radium pack, and 4.5 S.E.D. with x-rays.

3. The duration of the period of administration of the treatments is probably the most important single factor in protracted external irradiation. Each histologic type of neoplasm has its own rhythm of response and must be paralleled by a suitable time duration for the treatments. Furthermore, each type of ray quality has a characteristic period of greatest effectiveness, during which the destructive phase is in the ascendency and the healing phase has not yet commenced. The proper delicate adjustment of these two factors is essential to efficient protracted irradiation.

4. The double small 100-milligram pack, producing continuous irradiation for 24 hours a day, is an efficient therapeutic medium which closely rivals the large five-gram pack. It appears to produce the same effect upon the skin and mucosa with only four-fifths of the dose given with the larger pack.

ROENTGEN THERAPY IN SYRINGOMYELIA[1]

By FREDERICK W. O'BRIEN, A.B., M.D., *Boston*

From the Department of Roentgenology, Boston City Hospital, P. F. Butler, M.D., Chief

THE symptomatic relief following x-irradiation of a majority of a group of some thirty cases presenting the clinical syndrome of syringomyelia, treated in our clinic, has been so striking that it seems impelling to again bring this method of therapeusis to the attention of the English-speaking profession.

An original paper by Merrill (40), in 1924, who treated one case of syringomyelia with x-rays at the Massachusetts General Hospital, together with a translation of Delherm and Morel-Kahn's (13) original French article, comprise the entire contribution on the subject in English to date.

On the other hand, the roentgen therapy of syringomyelia has been practised rather generally on the Continent since the original communication of Raymond (46), in 1905, with favorable results.

Sahatchieff (51), after studying the published cases up to 1912, estimated that in 80 per cent of the subjects suffering from syringomyelia improvement had followed roentgen therapy.

Keijser (29), in 1926, reported 53 personal cases treated by x-ray, two-thirds of which showed a more or less subjective improvement which had lasted five years. Objective improvement occurred in only 15 cases of his group.

Delherm and Morel-Kahn (13, 14) observed 15 cases, nine of which (about 60 per cent) were improved, one unchanged, and five aggravated.

Czerny and Heinismann (12) published in 1930 their experience in the treatment of 124 cases of syringomyelia. Seventy of these had been observed for from two to five years. Of this group, 75 per cent showed good results, 13 per cent were arrested, while 12 per cent progressed further. Most of their cases were in men occupied at hard labor in whom the disease existed for from one to twenty years. In their group were 12 cases of syringomyelia in which nystagmus, sensory involvement of the trigeminus, disturbances of speech and swallowing, dissociated sensibility and headache disappeared entirely. Motor disturbance of the trigeminus was not favorably influenced.

These authors employed high voltage (180 K.V., 2.5 ma., and 0.5 Cu plus 1 Al filter) at a 45° angle, one-half to three-quarters E.S.D., not more than one-quarter skin dose daily, repeated at an interval of from one to three months. Repetition of the treatment was only done when the skin was perfectly normal.

Markow, Gorjelik, and Liwschitz (37), in 1932, reviewed critically 30 cases of their own. These comprised 25 males and 7 females from 10 to 55 years of age in whom the disease had existed for from one to over ten years. They also utilized high voltage therapy (170 K.V., 3.5 ma., and 0.5 Cu plus 1 Al filter), but with vertical centralization of the rays over the affected vertebral segment, giving a 90 per cent E.S.D. in three sessions with an interruption of only one day between the treatments. Such a series was repeated after six to eight weeks if necessary.

In 15 of their cases the different obstinate paresthesias partially came back. In 17 cases pain decreased considerably and in five cases did not recur; in three cases they observed an enormous decrease of hyperhydrosis, and also in four cases the disappearance of cyanosis of the extremities. In four cases they were able to obtain a complete restitution of touch

[1] Read in part at the Annual Meeting of the Radiological Society of North America, Atlantic City, Nov. 29, 1932, and at the Fourth International Congress of Radiology, Zürich, July 27, 1934.

sensibility. The pain sense was compensated much better and more quickly than the temperature sense. Of the various kinds of temperature sense, the sensation of cold was restored much better and more quickly than that of heat. There was nearly complete restitution of muscle power in five of their cases and a considerable improvement in three others. In six cases they observed restoration of the tendon reflexes. In only five of their cases did the disease progress in spite of treatment.

Giese and Ossinskaja (21) also, in 1932, published their observations on 128 patients treated by x-rays for syringomyelia. There was a follow-up in 85 of their cases, 50 per cent of which showed permanent improvement. Their technic was as follows: 160 K.V.; 4 ma.; 0.5 Cu plus 1 Al filter; field, 8 × 15 cm.; distance, 30 cm.; one-half to three-quarters E.S.D. to each portal.

The disease at the beginning of x-ray treatment in their cases had existed for from three months to twenty years. Thirty-seven cases were classed as syringobulbia. In these, there was also an associated lesion of the cervical and dorsal regions of the spinal cord. It is their opinion that only rarely may one expect a favorable outcome from irradiation if, after the first series, there has been no improvement in the objective symptoms of the disease, because in such cases the anatomical lesions are probably too extensive.

At the Boston City Hospital, since 1924, 30 cases have been treated by irradiation. Each case was first seen by the neurologic service and referred with the diagnosis of syringomyelia. In the group were 17 males and 13 females, divided in age groups as follows:

Up to 30 years	5
30–40	8
40–50	5
50–60	7
60–65	5

The cervical and dorsal segments were indicated as the site of the lesion in the majority of cases. Two cases of the first age group had involvement of the brain stem and medulla as well as a cervical lesion—both of these did well after irradiation. The improvement in patient M. S., aged 11 years, was most striking. He was disoriented and ataxic; he presented nystagmus, dysphonia, and dysphagia. There was immediate improvement in his speech and gait, so that within a month he was discharged to his home and returned to school. He did not return to the hospital to continue his x-ray treatments as directed, and he relapsed into his former condition and, following operative interference, died of pneumonia.

In 19 (or 61⅓ per cent) there was definite improvement—subjective, objective, or both—following irradiation. If we omit four patients too ill to continue treatment or who did not, and two cases lost sight of, the group followed is reduced to 24, of which number 75 per cent were benefited. There have been two deaths, one post-operative and the other from disease. Of the 22 patients now living, there are five who at no time could see improvement and in whom the disease has progressed obviously. Six of this series believed that the first few treatments aggravated their symptoms but all ultimately came into the improved group.

The nature of the improvement has been unmistakable—such as the return of thermal sensation, cessation of pain, restitution of voluntary muscular movement of the arms and legs, disappearance of ataxia, with improvement in walking and normal locomotion for some, restoration of normal speech and deglutition, the healing of trophic ulcers, transformation from semi-invalidism to self-helpfulness, and in some cases replacement in gainful occupation.

How x-irradiation acts to relieve symptoms in syringomyelia is problematical. One may think of the relief of pain as due to the now well accepted "anesthetic effect" and of the relief of certain other symptoms as due to the now equally well

accepted "counter-irritant effect" of roentgen rays.

Beaujard and Lhermitte (4), in 1907, reported some observations in animals sacrificed following irradiation. A degeneration of the fibers of the posterior cord and of the cells of the posterior horns, as well as ependymal hemorrhages, were noted in two guinea pigs, and in two others the histologic examination of the marrow did not show a single alteration. I have not found any observations as to changes noted post-irradiation in humans.

Certain it is that profound vascular changes, with death of tumor cells, have been observed in other conditions following intensive irradiation. Since gliomatous tissue is made up of young cells in the process of evolution, one might well expect it to be radiosensitive. If the results observed in other newgrowths hold here, then all the gliomatous cells will not be destroyed by irradiation. This may offer an explanation of the temporary arrest of the disease in some cases, later to be followed by its progression. If there has been degeneration of the fibers of the cord and destructive changes in the horns, it is hardly conceivable that irradiation will alter them.

An arrest of the disease may be hoped for if the symptoms are secondary to a limited area of gliosis, with inflammatory reaction, even in the presence of a cavity. If the cavity is an extensive one containing a large amount of fluid under pressure, it is possible that irradiation may increase the amount of fluid and aggravate the condition. This has been observed in the x-ray treatment of giant-cell tumors. On the other hand, these giant-cell tumors after liquefaction go on to organization if irradiation is continued, with a consequent cessation of pain. It is well recognized, too, that pleural effusions secondary to malignancy and abdominal ascites are absorbed, frequently following medium voltage x-ray therapy in relatively small doses. These facts are sufficient warrant for one to proceed with roentgen-ray therapy in those cases of syringomyelia which, on analysis, would appear to be hopeless on account of the extent of the cavity.

The clinical syndrome of syringomyelia may result from many processes: a genuine tumor associated with cavity; a limited gliosis with a small cavity; an extensive gliosis with a cavity which may extend from the equina to the pons; a cavity filled with fluid under pressure; a long-standing quiescent congenital defect lighted up perhaps by trauma, with resultant hemorrhage and cavity formation, or a slowly progressing gliosis which may remain practically stationary for twenty years or more.

I do not believe the age of the patient or the duration of the disease militate against beneficial symptomatic relief so much as the character of the pathologic changes present which produce the syringomyelic syndrome. In our improved group were cases of five, eight, ten, and eleven years' duration. In our unimproved group was one case each with symptoms of one, three, six, and twelve months' duration.

X-ray treatment has been directed first to the area as localized by the neurologic service, and then the remaining portions of the cord and medulla were irradiated. This latter maneuver I think especially important in view of the extensive and bizarre forms the underlying pathologic process may assume.

The primary beam is directed toward the canal through alternate right and left oblique portals (30 × 10 cm.). From necessity the early cases were treated with medium voltage, namely, 145 K.V.; 5 ma.; 0.25 mm. Cu plus 1 Al filter; 50 cm. F.S.D.; 15 minutes to each portal; six séances, with a total time dose of 90 minutes within three weeks (450 r measured in air λ_{eff} 0.220 Å.) repeated in one month. Later the following factors were employed: 185 K.V.; 5 ma.; 0.5 Cu plus 1 Al filter; 50 cm. F.S.D.; λ_{eff} 0.180 Å.; 160 r per portal every other day for four sittings, 640 r total per field. For some time past the factors have been 200 K.V.; 8 ma.; 0.5 mm. Cu plus 1 mm. Al filter;

50 cm. F.S.D.; λ_{eff} 0.175 Å.; 168 r per field per sitting.

Contrary to the experience of Czerny and Heinismann I have not found the skin of patients with syringomyelia more sensitive to x-rays than the skin of others coming for treatment.

Only one patient in the series complained of so-called roentgen sickness, and she was in the group receiving intensive treatment. The symptomatic relief, however, was so satisfying to the patient that she insisted on continuing treatments although it was necessary to hospitalize her.

Both patient and roentgen therapist may need encouragement to continue x-irradiation. Six in this series believed that their symptoms, especially pain, were aggravated by treatment at the start. Often the neurologist will submit an adverse report in spite of apparent objective and subjective improvement in the patient, because periosteal reflexes and muscle coordination have not returned to normal and certain parathesias, though modified, remain. Neither situation should deter one or the other from going forward with the treatments as planned.

Occasionally disturbance of the temperature sense will continue for some time after the restitution of other kinds of cutaneous sensibility. Why the function of the pain-conducting fibers should be restored more quickly under the influence of irradiation than the function of the temperature-conducting fibers is not clear.

It has been our experience—and noted by others—that improvement of cutaneous sensibility generally occurred first in those regions of the skin which corresponded to the marginal segments of the involved part of the spinal cord and in which the pathologic process had developed last. An obvious explanation of this would be that, other things being equal, the part last to be involved might be expected to be more sensitive to x-rays than the segment diseased for a longer time.

Favorable results occurred in our group using medium as well as high voltage x-rays. Good results have been reported from other clinics with low voltage. This raises the question again of wave length and absorbed radiation. The total dosage in roentgens per case administered in our own clinic in the treatment of this disease since employing high voltage is contrary to all older concepts and is comparable to the protracted high tension low intensity irradiation now being employed by Coutard and his school with such brilliant results. My impression is that our later cases have shown more immediate improvement than the earlier ones because of the employment of this method of irradiation. Irradiation sickness has been the exception and skin damage has not been observed.

One's enthusiasm may be tempered by the knowledge that this disease when not treated may show periods of remission or be quiescent over a considerable length of time. Taylor, Greenfield, and Martin (57) report a case that underwent no change of consequence during a period of twenty-four years but this is the exception and not the rule. Improvement following irradiation occurred in so many cases and so promptly that it is unreasonable to say that it is due to spontaneous remission or the natural history of the disease.

For more than a quarter of a century now no other method of treatment has shown such a high percentage of favorable results, so that irradiation of syringomyelia may conservatively be pronounced the method of choice.

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OSTEITIS TUBERCULOSA MULTIPLEX CYSTICA[1]

WITH REPORT OF TWO CASES

By JACOB H. VASTINE, M.D., Clinical Professor of Radiology, Woman's Medical College of Pennsylvania, *and* EMILY P. BACON, M.D., Professor of Pediatrics, Woman's Medical College of Pennsylvania, *Philadelphia*

THERE are two types of tuberculosis of the bones. The first and most common is the one occurring in the region of the metaphysis, where there is usually only one bone and joint involved. The dissemination is hematogenous and the predilection for the metaphyseal region according to the work of Lexer is to be found in the peculiar vascular structure in this region in the growing long bones. Schulze, working with experimental animals, injected dye in Ringer's solution in the femoral artery which lodged in the end-arteries in the metaphysis with a resulting circumscribed ischemia. He suggests that tubercle bacilli could produce a similar embolus with resulting caseation. The process extends, infiltrating the epiphysis and destroying it, ultimately involving the joint; it may become arrested at any stage of its development, be surrounded by fibrous tissue, and present a fibrous cystic appearance which remains unchanged over a long period.

The second and rarer form of tuberculosis of the bones is that one involving the diaphysis, this form usually being multiple. The dissemination is probably hematogenous. Fibrosis frequently predominates, surrounding the caseations and resulting in a cyst which remains comparatively quiescent and unchanged over a rather long period. This type was probably first described by Kreibish, in 1904, which, in appearance, closely corresponded to cases later reported by Jüngling, in 1920. Reider, in 1910, published an article on the combination of chronic osteomyelitis with lupus pernio. German dermatologists had long known that the so-called tuberculides of the skin (lupus pernio and Boeck's sarcoid) were not infrequently associated with

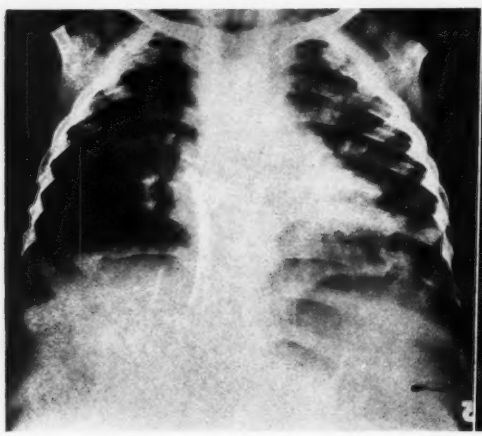


Fig. 1. Case R. A. Film showing a tuberculous infiltration of the lungs with enlarged mediastinal glands and cystic areas in several of the ribs.

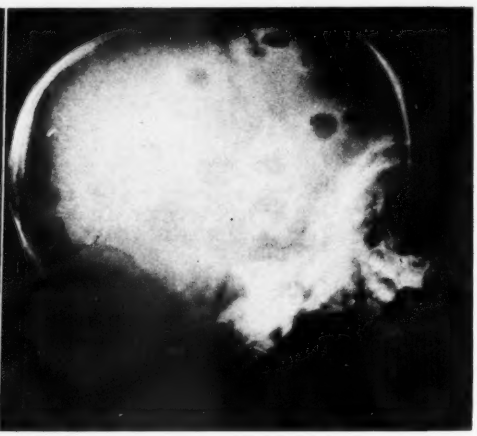


Fig. 2. Case R. A. Film of skull showing numerous cystic areas in the frontal bone, parietal bones, occipital bone, and in the mandible. These are clear-cut areas of bone destruction which are smoothly outlined and surrounded by a slight degree of sclerosis.

[1] Presented before the Philadelphia Roentgen Ray Society, Nov. 1, 1934.

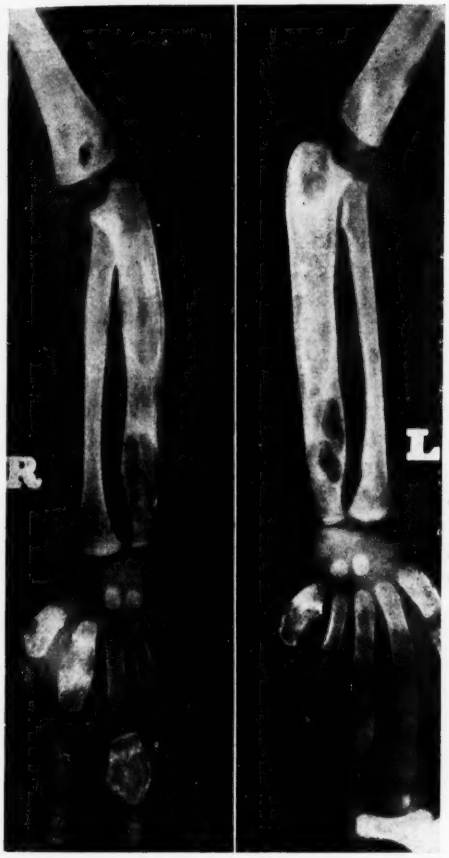


Fig. 3. Case R. A. Film showing a cystic tuberculous osteitis with expansion of the cortex, sclerosis, and bone destruction in the bones of both forearms and hands.

Fig. 4. Case R. A. Film showing cystic changes in both femora.

chronic bone changes in the hands and feet. Jüngling, in 1920, made the most lucid and comprehensive observations of these cystic changes of bone to which he applied the name "osteitis tuberculosa multiplex cystica." In 1924, Fleischner investigated the dermatologic literature and found a great number of cases with bone changes in the hands and feet. There is comparatively little in the American literature regarding the bone changes associated with tuberculous lesions of the skin. Doub and Menagy, in 1929, reviewed the scanty literature and presented two cases with bone lesions occurring in sarcoid in adults. Jüngling, in 1928, reviewed the literature and reported 46 cases to which he added nine of his own. Practically all of these have involved the phalanges, metacarpals, and metatarsals, but rarely the larger long bones. Van Alstyne and Gowen reported a multiple cystic type of tuberculosis occurring in the long bones in an adult. Schwenkter, in 1931, reported on a multiple cystic tuberculosis of the bone in an infant one year of age.

We are reporting two cases because of the paucity of the cases in the literature. There is only one case occurring in an infant recorded in American literature. One of our cases is of especial interest because of the widespread distribution of the lesions. The second case had only two areas involved.

CLINICAL ASPECTS

Cystic tuberculosis of bones in children is due to a dissemination of the tubercle bacilli through the blood stream, probably from a broken-down, caseous lymph node in the chest. This must have occurred

Fig. 5. Case R. A. Anteroposterior and lateral films of the right lower leg and ankle, showing extensive cystic areas in the tibia and fibula surrounded by osteitis, with a defect in the lower end of the fibula at the site from which a biopsy was taken.

a considerable time before the cystic condition became manifest in the bones, and the patient may therefore have recovered from the acute clinical symptoms and be a well-nourished, well-developed child.

There may or may not be swelling over the involved bones and since these cystic areas are apparently painless, the condition is doubtless more common than the few reported cases in the literature would indicate. This is illustrated by one of our cases, admitted to another hospital two years after being examined by us. The patient died of bronchopneumonia and an autopsy was performed upon the abdomen and chest without the recognition by the clinician or pathologist of any tumefactions over the bones. Cystic tuberculosis of bone is probably present but unrecognized in many cases of infantile tuberculosis. It is not diagnosed because there is no pain, tenderness, nor evidence of inflammation. Routine fluoroscopy of the long bones in infants, examined roentgenologically with a question of tuberculosis in the chest, may lead to a more frequent recognition of the condition.

The cystic areas sometimes break through the cortex, form abscesses which rupture through the overlying skin, and sinuses develop. This occurred in the angle of the jaw and the first metacarpal in one of our cases, and over the right ulna in another case, with complete healing of the sinuses eventually in both. The cystic condition of the bones in the one case went on to complete healing, while they were regressing in the other when the child died from bronchopneumonia, two years after having been first seen by us.

Fever is not necessarily present with cystic tuberculosis of the bones. It may occur as a result of secondary infection through a draining sinus, or as a result of the primary tuberculous process in the chest.

The blood picture is not characteristic: there is an associated secondary anemia. A leukopenia and slight lymphocytosis may be found. The blood chemistry is not changed, this being an important diagnostic aid in differentiating cystic tuberculosis from osteitis fibrosa cystica.

Diagnosis should be made from the roentgenograms, in which the appearance is quite characteristic. Confusion may arise in differentiating this condition from osteitis fibrosa cystica, chrondromatosis, syphilis, etc. The blood chemistry is changed in osteitis fibrosa cystica. The blood calcium and phosphorus are within the normal limits in cystic tuberculosis. Denks recently discussed the differential features of cystic tuberculosis and enchondromas.

A strongly positive tuberculin reaction is an important diagnostic evidence. Negative serologic tests are valuable in making a diagnosis of syphilis improbable although cystic tuberculosis of bone and syphilis may occur coincidentally.

Clinical or roentgen evidence of an infantile tuberculous process in the chest, particularly involvement of the bronchial glands, is found in the following cases.

Case 1. R. A., a colored boy, aged 17 months, was first examined in February, 1932. The chief complaint was "lumps" on fingers, wrist, ankle, and foot, which had been present since the child was six months old. The skin over one of these had ulcerated four months previous to examination. The child's birth and development had been normal, and his general health had always been good. He had had no acute infections except for two mild colds. The family history was negative. Careful questioning revealed the fact that a boarder with active tuberculosis had lived in the same house with the family but had been removed to the hospital just before the baby was born. No attempt to clean the house had been made subsequent to his removal.

On physical examination, the child was found to be poorly nourished, weighing only eighteen and one-half pounds. His tonsils were large and infected. He had moderate rickets. The rest of his physical examination was essentially negative except for the bone deformities; only eight of these were noted before the roentgen examination. Two metacarpal and two metatarsal bones were involved as well as three phalanges. These swellings were hard, painless, and pyriform in shape. Two hard, smooth prominences about one inch in diameter were palpated on the forehead. A bony swelling on the lower end of the left ulna was partly obscured by an overlying, granulating ulcer of the skin. Another was found in the region of the external malleolus.

The blood count revealed a moderately severe anemia. The urine examinations were negative. The blood Ca was 7 mg. per 100 c.c. serum. The Wassermann test was negative. Intracutaneous tuberculins done on admission were negative up to 1 mg.: these were not repeated later.

During the child's four months' stay in the hospital, he had a very severe and prolonged attack of bilateral, suppurative otitis media, bronchopneumonia, and marked cervical adenitis. His temperature was elevated at various times to 103 and 104, but usually fluctuated between 98 and 100 degrees. Two months after his admission he developed styes and a phlyctenular conjunctivitis. His weight was stationary the first two months of his hospitalization but increased five pounds the last two months. His general condition improved remarkably during the last six weeks in the hospital, as did also his ears and chest. Little improvement was noted in the bony prominences. He was discharged June 11, 1932.

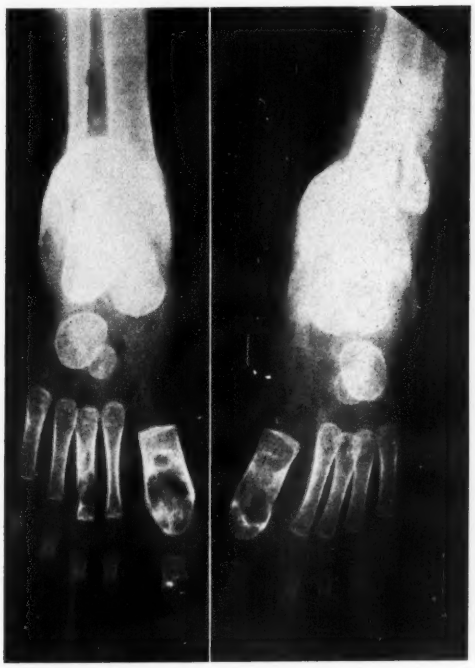


Fig. 6. Case R. A. Film showing tuberculous cystic osteitis of metatarsals and phalanges of the feet.

Five weeks later, the swellings in the hands were much smaller and the bony deformities of the forehead had disappeared. Scar tissue was present at the site of the former ulceration, and also at the site of the operative area where a biopsy had been done on February 16, on a fragment of the fibula. A microscopic description of biopsy material follows: Sections show fragments of bone and granulation tissue. Typical tubercles are present in some places in the granulation tissue.

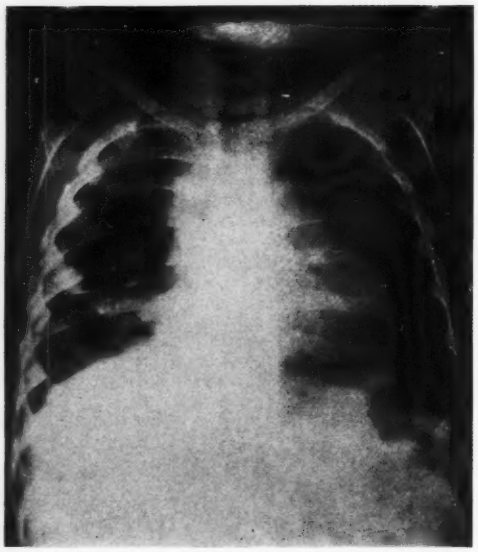


Fig. 7. Case E. F. Film of chest showing tuberculous infiltration in right lung with enlarged mediastinal glands and pleural effusion.

There are also areas of necrosis (caseation). In some places the bone is eroded and the bone corpuscles stain poorly. Near the granulation tissue, the bone shows very active growth, the marrow spaces being lined by large osteoblasts, sometimes several layers deep. No typical bone marrow is seen, however. Pathologic diagnosis: tuberculosis of the bone with a rather unusual amount of bone proliferation.

Case 2. E. F., aged 2 years, was first examined on Feb. 22, 1930. The chief complaints were a running ear of two months' duration, and a swelling on the left hand for one month. He had had a cold and cough for three weeks. History revealed that he had always had a tendency to catch cold. He had a severe case of pertussis and pneumonia at one and one-half years of age. Family history was negative for syphilis and tuberculosis. No history of exposure to tuberculosis was elicited.

On examination the child was found to be suffering from suppurative otitis media of the left ear, and very marked left-sided cervical adenitis. He had signs of consolidation and fluid in his right chest. His highest temperature was 101 degrees. He coughed frequently and often with an inspiratory crowing sound.

Two tense, firm, painless swellings were present in the dorsum of the left hand and one on the thumb; also there was a hard bony enlargement at the angle of the left jaw. The blood showed a moderately severe anemia. Blood calcium was 8 mg. per 100 c.c. of serum. Urines were negative. The blood Wassermann was negative. Intracutaneous tuberculin test was positive in 24 and 48 hours with a 0.1 mg. dose.

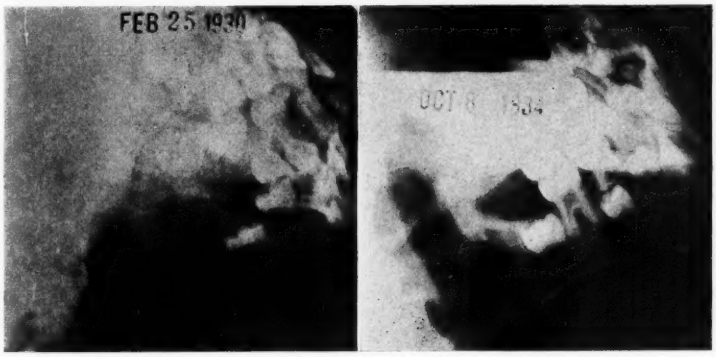
The child remained in the hospital four weeks, during which time his temperature usually ranged between 99 and 100, reaching 101 on only four occasions. After the first two weeks, he gained fairly well in weight and his general condition definitely improved. His ear cleared up considerably but not entirely. There was an improvement in the physical signs in his chest. Cervical adenitis persisted. There was little improvement in the bony swellings. He was discharged on March 18, 1930, with the diagnosis of tuberculous bronchopneumonia, dactylitis, tuberculous cyst in the angle of jaw, and chronic otitis media.

ROENTGENOLOGIC APPEARANCE

Jüngling says the roentgenogram is characteristic and is the chief means of distinguishing tuberculids of the bone. There is a rarefaction originating in the marrow which may be single or multiple, presenting a spotty appearance if multiple. The process may spread diffusely through the entire involved bone, or may appear as a circumscribed rarefaction in certain sites of predilection, particularly in the heads of phalanges where the condition is nearly always multipled. There have been two types described by Jüngling, first, the diffuse type, and second, the circumscribed type.

In the diffuse type, the cortex and medulla cannot be differentiated. The entire bone is characterized by a web-like structure of increased density. This type

is the initial stage and represents the more acute and florid process. He described the large spotted type, and the small



(*a*) (*b*)

Fig. 8. Case E. F. (*a*) Film of mandible showing a cystic area. (*b*) Same case six and one-half years later, showing slight defect at the lower margin of the jaw, but no definite evidence of the former cyst.

spotted type of diffuse involvement, the latter being a manifestation of a more slow, torpid course. The bone is usually larger in diameter. In the large diffuse type, there may be destruction of the entire phalanx, as in the case reported by Fleischner, or there may be destruction to the extent that spontaneous fractures occur. In a case in which there is no secondary infection, there is only moderate sclerosis of bone. The bone atrophy which is seen in the more common tuberculous process of bone is less noticeable in these cases.

The circumscribed type is characterized by a round, rather smoothly outlined, punched-out area of decreased density. The cortex is a paper-thin shell which may or may not be penetrated. There may be a faint ring of sclerosis about these cystic areas, or there may simply be a clear-cut margin, with no alteration in density of the surrounding bone. The cortex is shown to be either expanded or destroyed. This circumscribed type represents a healing stage, and these cysts may proceed without appreciable change for a long period of time, may regress with little subsequent deformity of the bone, or may progress to the formation of abscesses with sinus formation.

Case R. A. On Feb. 3, 1932, films and fluoroscopy of the chest showed an extensive mottled filtration about both hili, with an increase in the transverse diameter of the mediastinal shadows suggesting the presence of an infantile type of tuberculosis. There was a small, sharply circumscribed area of decreased density in the sixth rib on the left side posteriorly. There was a symmetrically placed area of decreased density in the same rib on the right side.

Roentgenograms of the skull showed numerous homogeneous areas of decreased density involving the frontal, occipital, and both parietal bones. These ranged in diameter from 5 to 20 millimeters. There was little evidence of normal bony structure or trabeculation in these areas. There was a rather sharply outlined margin, with slight increase in density, suggesting bone reaction about some of these but not about all of them. This is apparently the circumscribed type, described by Jüngling, which represents a more or less stationary phase of the disease. There was no breaking down during the two years preceding the fatal termination of the patient's life from another cause.

There were two areas of decreased density in the right side of the mandible, near the angle, each measuring about one centimeter in diameter. There was slight in-

crease in density at the periphery of these areas. These broke through the cortex, producing an abscess in the cervical region with a resulting sinus which eventually healed.

Fig. 9. Case E. F. (*Left*) Film showing dactylitis with cystic area. (*Right*) Same patient four and one-half years later with the fistula healed and osseous process healed or quiescent.

Films of the arm show two rather large areas of decreased density in the right ulna which measure approximately three centimeters in length and are the entire width of the bone, being covered by a rather thin shell of cortex. There is a slight periosteal reaction of overlying bone with increased density at the periphery of these cysts, and definite expansion of the cortex. These are evidently the circumscribed cysts of Jüngling. There is a small area of increased density in the upper third of the diaphysis of the right ulna, with slight expansion of the cortex and slight evidence of periosteal reaction. This probably represents a healing or regressing cyst.

There is an irregular area of decreased density at the lower end of the left ulna which is approximately three centimeters in length and almost the entire diameter of the bone. This has a loculated appearance. The cortex is expanded and there is a slight increase in density of the overlying bone. There is a similar cystic area at the proximal end of the left ulna.

In the intervening bone, the presence of mottled areas of increased and decreased density suggest the appearance of the diffuse type of Jüngling. There is a small area of decreased density at the lower end of the left ulna.

Films of the right hand show a diffuse involvement of the first metacarpal, the second metacarpal, and the proximal phalanx of the middle finger. There is expansion and breaking through of the cortex. There is a similar appearance of the first and fifth metacarpal of the left hand, and the middle phalanx of the ring finger of the left hand. Figure 4 illustrates the hands of the same case two months later

and comparison with Figure 3 shows these areas of decreased density to be assuming a circumscribed nature, representing the healing or quiescent stage as described by Jüngling. This comparison of a change from the diffuse into the circumscribed type is particularly well seen in the proximal phalanx of the ring finger of the right hand, where the later films show the cortex to be more smooth and dense, and the cystic area to be more homogeneous with absence of trabeculations.

There are small areas of increased density in the lower ends of both femora, measuring approximately one centimeter in diameter, entirely within the diaphysis. These are apparently the circumscribed type of cysts.

Films of the left lower leg show no demonstrable evidence of involvement. Anteroposterior and lateral films of the right lower leg show clear areas of decreased density in the middle third of the tibia—apparently a circumscribed type. There is only slight expansion of the cortex and slight periosteal reaction with a moderate increase in density surrounding this cyst. There is a more irregular, less circumscribed or more diffuse type of decreased density involving the upper third of the tibia to within about one centimeter of the end of the diaphysis. There are two areas of decreased density in the fibula; one in the middle third, and one at the lower end of the diaphysis, about two and one-half centimeters in length and involving almost the entire diameter of the bone. The cortex is thin and in the lower one is completely destroyed in the posterolateral aspect where there has been a rupture of the cortex with abscess formation, with a draining sinus to the lateral aspect of the ankle. These films of the right lower leg exhibit the following different stages to which cystic tuberculosis may progress: the diffuse type, the sharply circumscribed, more or less quiescent type, and rupture through the cortex with sinus formation. Films of the feet show clear areas of decreased density involving the first and third metatarsals and proximal phalanges of the great toe of the left foot, and first metatarsal of the right foot. These are of the diffuse type, probably assuming the quiescent or circumscribed stage.

Case E. F. Films of the chest and fluoroscopy show an extensive mottled increase in density about both hili, being more marked on the right side. There is an increase in the transverse diameter of the mediastinal structures suggesting the presence of large bronchial or mediastinal glands. Also, there is a definite increase in density about the periphery, suggesting the presence of thickened pleura with a local collection of fluid between the middle and upper lobes. A re-examination of the chest 56 months later shows an increase in density about the hili with calcification; a residuum of his former infantile type of tuberculosis, and probably of little significance at the time of the latter examination. This corresponds with his improvement clinically. At the time of the latter examination, he was a strong, well nourished, colored child, six and one-half years of age.

A film of the lower jaw shows an area of decreased density measuring approximately 1 × 1.5 cm. near the angle, with expansion and thinning of the cortex presenting the appearance of a blister near the angle of the mandible. A film taken of this region 56 months later shows an irregularity and a depression of the cortex at the site of the former cystic area, but there is no longer any evidence of decreased density in this region.

In the interim between the two examinations there was a breaking through of the cortex with abscess formation in the cervical region and formation of a draining sinus which ultimately healed, and at the present time is apparent only as a small scar. There are no calcified tuberculous nodes in the neck.

Roentgenograms of the hand show a definite increase in density of the first metatarsal, with numerous small areas of decreased density, coarsening of the bone markings, and widening of the diameter with a rather sharply punched-out beginning area of decreased density at the

center of the bone. A film taken 56 months later shows little appreciable evidence of the former disease. In the interim, there was a rupture through the cortex with abscess and sinus formation which has healed and at the present time is apparent only as a small scar on the dorsal surface of the hand.

SUMMARY

There are reported two cases of cystic tuberculosis of the bone. The diagnosis in one of these was made by biopsy. The diagnosis in the other case was made clinically and roentgenologically but was not confirmed. The roentgenologic findings are quite diagnostic. These cases are reported because there is only one other case of cystic tuberculosis of bone occurring in an infant, that by Schwenkter, reported in the American literature. Since there is not always a conspicuous tumefaction over these cystic areas, it is suggested that the presence of this condition is often unrecognized and is probably far more common than the number of cases in the literature would indicate.

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VOLUME-INCREASE OF BACTERIA FROM X-RAY IRRADIATION

By THOMAS J. DIETZ

Department of Physics, Union College, *Schenectady, N. Y.*

EXPOSURE to x-rays is by nature lethal to living cells, but it sometimes happens that small dosages bring about enhanced growth, or swelling of cell cytoplasm. It may be said that in general small dosages of x-rays cause stimulation of various chemical reactions in biological colloidal systems, while larger dosages cause inhibition and destruction. However, the opinion has been expressed that the present-day evidence is inclined toward the conclusion that radiations do not directly stimulate the normal activities of the cell, and that their primary effect is always an injury from which the cell may recover perfectly (1). The quality of x-rays and the period of exposure that bring about cell swelling are worthy of investigation because of the subtle cell changes supposedly involved. A simple explanation of the phenomenon involves an increased capacity of the irradiated cells for the absorption of water from the medium through an altered cell membrane. It is suggested that intracellular changes produce new electrolytes by the decomposition of salts, proteins, and fats, and that water is taken in by simple osmosis (2). Such an interpretation necessarily suggests an alteration in cell constituents, and thus an abnormal condition.

The mechanics of cytoplasmic swelling of bacteria and of enhanced bacterial growth, as caused by exposure to x-rays, is quite obscure, and facts concerning it are of fundamental importance. The writer has undertaken the study of these effects, and the work herein described was a definite preliminary part of the investigation. Experiment showed that under the proper conditions volume-increase occurred when bacteria were exposed to x-rays. Whether this volume-increase was enhanced growth, cytoplasmic swelling, or a combination of both, is a question to be considered. This paper is concerned primarily with the

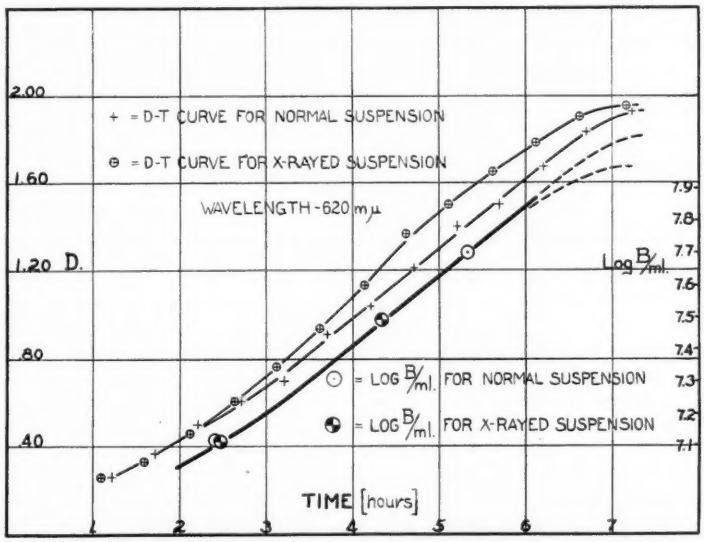

Fig. 1. Optical density-time curves and bacterial count-time curves plotted from observations on the irradiated and control suspensions as listed in Table I. The irradiated suspension was first exposed to x-rays in the lag phase.

observed increase in volume *per bacterium* and the resulting deductions. The investigation was carried out for *Bacillus coli* alone, but the effect is not believed to be unique for that organism. The problem was considered from the point of growth-rates of suspensions of *B. coli*, *i.e.*, turbidity changes of the growing suspensions. This method of approach was more feasible than the study of growth on a solid medium, although it was not certain that bacterial swelling under irradiation was conditioned by a liquid medium.

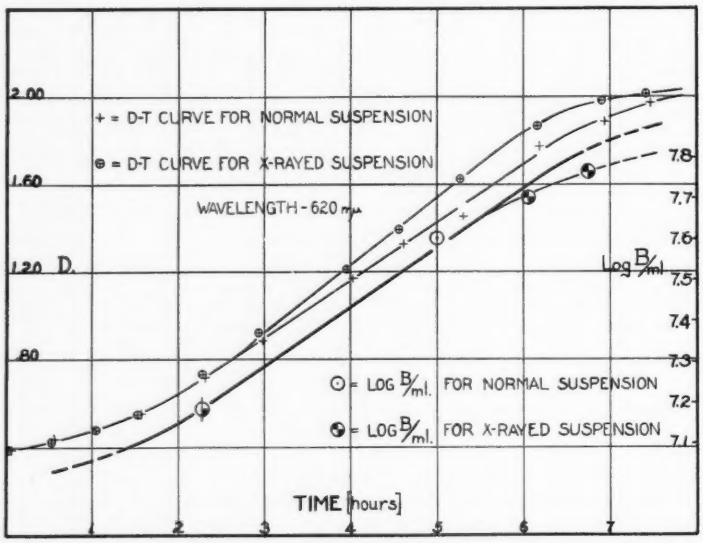

Fig. 2. Optical density-time curves and bacterial count-time curves plotted from observations on the irradiated and control suspensions as listed in Table II. The irradiated suspension was exposed to x-rays entirely in the logarithmic growth phase.

APPARATUS AND METHODS

The rate of bacterial growth was recorded by means of measurements upon the light transmission of a suspension of *B. coli* as related to the transmission of sterile broth. A spectrophotometer was used, because intensity values of the transmitted light for different parts of the spectrum seemed to open paths to additional facts concerning growth analysis. The spectrophotometer consisted of a source of light, an improved Martens-type photometer, a constant-deviation spectrometer, and specimen tubes for the examination of liquids. The analyzer circle of the photometer was graduated so that one quadrant read in optical densities, a second in transmission per cent, and a third and fourth in degrees. Recorded values of suspension growth were taken in terms of optical density rather than actual percentage of transmission. Optical density was a function increasing with bacterial growth, thus giving a curve with a positive slope when optical density was plotted against time.

Optical density is herein defined as

$$D = \log \frac{I_0}{I}, \qquad (1)$$

where D = optical density reading,
I_0 = intensity of light after traversing control tube containing sterile broth,
I = intensity of light after traversing tube containing growing bacterial suspension.

Preliminary experiments showed that the optical density was related to the

actual bacterial total count according to the relations expressed below. Analysis was confined to the phase of logarithmic growth with the straight line relation,

$$\text{Log } B = a_1 t + b_1, \tag{2}$$

where B = change in number of bacteria during time interval, t,
t = time interval under consideration,
a_1 and b_1 are constants depending upon suspension, temperature, PH, etc.

Likewise in the corresponding region of the optical density-time curve the relation was

$$\text{Log } \frac{I_0}{I} = a_2 t + b_2. \tag{3}$$

The bacterial count-time curve and the optical density-time curve proved to be substantially similar so that for any one suspension

$$a_1 = k a_2. \tag{4}$$

Then

$$\text{Log } B - k \text{ Log } \frac{I_0}{I} = (a_1 - k a_2)t + b_1 - k b_2,$$

or

$$Ln\, B - Ln \left[\frac{I_0}{I}\right]^k = 2.303\, b,$$

from which

$$\frac{B}{\left[\frac{I_0}{I}\right]^k} = \text{Constant}. \tag{5}$$

Thus it was possible to study the growth of *B. coli* under x-ray irradiation by means of optical density observations with a fair degree of accuracy. No mention was made of specimen tube length because it affected only the constants of the relation. The specimen tubes were 10 cm. long and 1.5 cm. in diameter, and were each supplied with an opening through which a sample of the suspension could be withdrawn at any time for cell count.

The x-ray tube used in the investigation was an ordinary self-rectifying tungsten target tube operating at approximately 75 kilovolts peak voltage, as measured with a sphere gap, and between 1.2 and 1.6 milliamperes tube current. Tube current was varied for different experiments, but

TABLE I.—SPECTROPHOTOMETRIC READINGS AT WAVE LENGTH 620 Mμ

Control Suspension Time	D	X-rayed Suspension Time	D
5 min.	0.26	0 min.	0.26
35	0.37	30	0.33
66	0.50	60	0.46
96	0.61	91	0.61
125	0.70	120	0.76
155	0.91	150	0.93
185	1.04	181	1.13
215	1.21	210	1.37
245	1.40	240	1.50
275	1.50	270	1.65
305	1.67	300	1.78
335	1.83	330	1.90

Periods of Irradiation

1. 40th minute to 60th minute
2. 65th minute to 90th minute
3. 95th minute to 120th minute
4. 125th minute to 150th minute
5. 155th minute to 180th minute

Total exposure.....120 min.
Tube current.....1.0 ma.
Target distance.....9 cm.
Temperature.....24° C.

Total Cell Count

Control Suspension Time	B/ml.	X-rayed Suspension Time	B/ml.
85th min.	3.65×10^7	87th min.	3.64×10^7
260th min.	7.10×10^7	200th min.	5.57×10^7

(The data in this table are plotted in Figure 1.)

The total volume per average bacterium was calculated from photomicrographs by the formula, length × breadth × $\pi/4$.

Total Volume per Average Normal Bacterium.....0.75 cubic micra
Total Volume per Average Irradiated Bacterium.....2.00 cubic micra

was held constant throughout each experiment. The target was placed at a distance of 9 cm. from the midpoint of the axis of revolution of the specimen tube. Proper cooling of the specimen tube under exposure was necessary so that the temperature of the contained suspension remained equal to that of the control suspension.

The suspension under observation was prepared by inoculating nutrient broth with *B. coli* from a 24-hour culture on nutrient agar; the inoculation was sufficient to give an initial concentration of approximately 1×10^7 B/ml. The suspension was then placed in each of two specimen tubes for spectrophotometric study. It was found most convenient and, in fact, quite necessary to have the suspensions grow at temperatures ranging

between 20° C. and 25° C. As soon as the suspensions began to show active growth one of the specimen tubes was exposed to x-rays; the other was used as a control. The irradiated specimen tube was given a dose consisting of fractional exposures of from 20 to 25 minutes each, with 10-minute intervals between exposures for observation; the total dose varied between 90 and 120 minutes for different experiments. No attempt of dosage ionization measurement was made because it is believed that this bacterial swelling is not sufficiently critical to necessitate accurate duplication of biological dosage. Spectrophotometric readings were taken at half-hour intervals for several wave lengths from 600 mμ to 700 mμ, inclusive. Regular variations occurred in the optical density-time curves plotted for different wave lengths, and were caused by the relative spectral energy distribution of the source. An optical density-time curve, which held true regardless of wave length, could be calculated by correcting for relative spectral energy distribution of the source and for visibility of radiant energy (3).

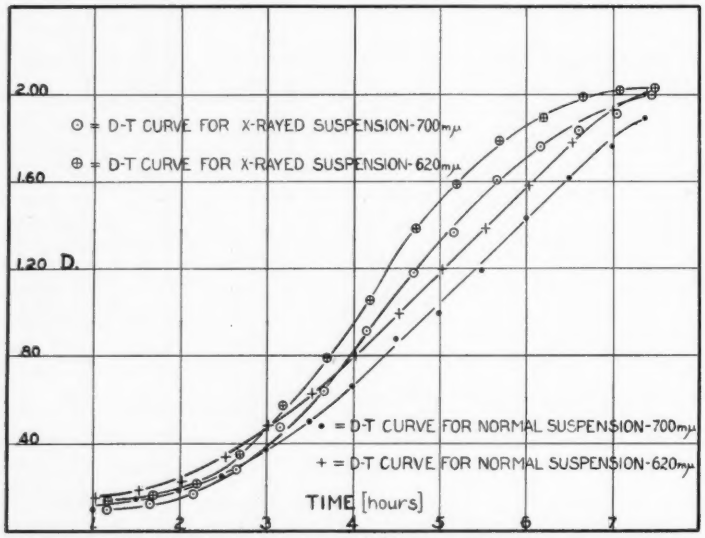

Fig. 3. Optical density-time curves plotted for two different wave lengths in the red from observations on the irradiated and control suspensions as listed in Table III. X-ray exposure of the irradiated suspension was in the lag phase of growth.

RESULTS

Several experiments are recorded here with tables and graphs to illustrate the points of interest. Examination of the optical density-time curves for the several experiments revealed the optical density of the irradiated suspension to be increasing at a faster rate than that of the control suspension. Actual cell count indicated that, at any time during the major portion of the phase of logarithmic growth, the total cell number was the same for both suspensions. Mathematical analysis was confined to Table I, because that experiment showed most clearly the relation between the normal suspension and the irradiated suspension. The morphological relation between the normal bacteria and the irradiated bacteria is clearly indicated in Figures 4, 5, and 6. Figure 4 is a sample of the normal suspension taken during the second hour of logarithmic growth; Figure 5 is a sample of the irradiated suspension also taken during the second hour of logarithmic growth. Figure 6 is a sample of the irradiated suspension taken at the beginning of the maximum

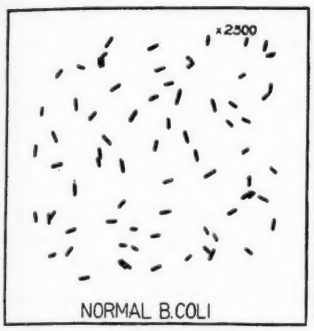

Fig. 4. Tracing from a photomicrograph of a stained preparation of normal *B. coli*. The prepared sample was taken from the suspension during the second hour of logarithmic growth.

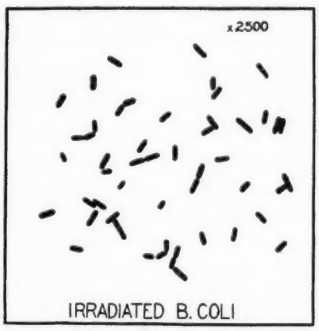

Fig. 5. Tracing from a photomicrograph of a stained preparation of irradiated *B. coli*. The prepared sample was taken from the suspension during the second hour of logarithmic growth.

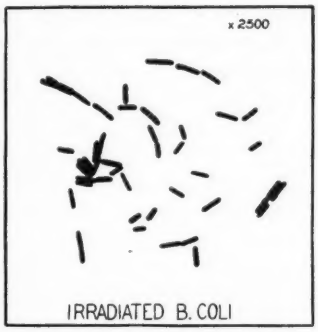

Fig. 6. Tracing from a photomicrograph of a stained preparation of irradiated *B. coli*. The prepared sample was taken from the suspension during the phase of negative acceleration directly preceding maximum growth.

rest phase of growth; inhibition of the ability of fission was noticeable.

DISCUSSION

The increase in volume of irradiated bacteria over normal bacteria was of considerable importance since the x-rays had caused no apparent inhibition of fission. For this reason it seemed permissible to consider bacterial volume-increase as a major effect. The writer did not attempt to explain the phenomenon except so far as the actual physical measurements permitted. The empirical formulæ developed were deemed applicable only under the stated conditions. Naturally the experimental evidence cited here only allows the formulæ to be considered as food for discussion.

In accordance with the theoretical procedure, the effect, the swelling of irradiated bacteria, was built upon two distinct considerations; namely, the uninhibited ability of fission during the major portion of the phase of logarithmic growth, and the observed increase in volume of the irradiated bacteria. It was obviously necessary to avoid any inhibition of the property of fission if the mathematical analysis were to be considered of value. Inhibition was noticeable as the growing irradiated suspension approached the resting phase, but it was probably a secondary reaction to the x-rays and was not of serious consequence. The marked effect of irradiation, the volume-increase of the irradiated bacteria, as measured under the microscope, was much greater than that indicated by the increase in optical density. This observation led to the temporary deduction that the bacteria had absorbed

TABLE II.—SPECTROPHOTOMETRIC READINGS AT WAVE LENGTH 620 Mμ

Control Suspension		X-rayed Suspension	
Time	D	Time	D
4 min.	0.39	2 min.	0.39
34	0.44	32	0.43
64	0.48	63	0.48
94	0.55	92	0.55
139	0.72	137	0.73
179	0.89	176	0.92
241	1.17	237	1.21
276	1.33	273	1.39
318	1.45	316	1.62
371	1.77	369	1.86
418	1.88	416	1.98
448	1.97	445	2.01

Periods of Irradiation

1. 150th minute to 170th minute
2. 182nd minute to 202nd minute
3. 211th minute to 231st minute
4. 245th minute to 270th minute
5. 280th minute to 307th minute
6. 344th minute to 365th minute

Total exposure.....133 min.
Tube current.....1.6 ma.
Target distance.....9 cm.
Temperature.....23° C.

Total Cell Count

Control Suspension		X-rayed Suspension	
Time	B/ml.	Time	B/ml.
138th min.	1.53×10^7	138th min.	1.53×10^7
300th min.	4.00×10^7	363rd min.	5.05×10^7
		405th min.	5.78×10^7

(The data of Table II are plotted in Figure 2.)

water from the medium as a result of irradiation; optical density measurements apparently did not give evidence of absorbed water. Contrary to supposition, no early inhibition of cell activity was induced by the water absorbed, and the increase in volume *per bacterium* persisted until the irradiated suspension entered the negative acceleration phase.

If the average cell volume and the absorption coefficient per average bacterium are assumed to be constant in the phase of logarithmic growth, it is possible to write Equation (5) as

$$\text{Log}\frac{I_0}{I} = k' \text{ Log } [B\bar{v}a] + C \qquad (6)$$

where

$\bar{v}$ = average effective cell volume,
a = number proportional to absorption coefficient.

The meaning of Equation (6) is decidedly limited; it cannot be said that either $\bar{v}$ or a remain constant over an extended period of time, *i.e.*, three hours or more. However, serious error is avoided when Equation (6) is applied to the same limited region of two similar growth curves; in the present case a curve of a normal suspension is compared with that of an irradiated suspension. The number, a, proportional to the absorption coefficient, is considered constant for both normal and irradiated bacteria because a was directly related to the constitution of cell protoplasm; any change in the absorption coefficient was interpreted as an abnormality. In Equation (6) as evaluated for the normal suspension from Table I, a is chosen so that the product, $\bar{v} \cdot a$, is equal to unity. The effective volume and the measured volume are considered equal for the normal bacterium. The only change made in Equation (6) to calculate $\bar{v}$ for the irradiated bacterium is the substitution of the value of *log* I_0/I for that suspension; *log* B remains unchanged as well as all of the constants.

The value of $\bar{v}$ for the average normal bacterium was found to be 0.75 cubic micra by micrometer measurement, while the calculated value of $\bar{v}$ for the average irradiated bacterium was 0.85 cubic micra. This value of $\bar{v}$ for the average irradiated bacterium could not be the total volume since that was previously measured to be 2.00 cubic micra. The calculated volume per average irradiated bacterium, *i.e.*, 0.85 cubic micra, was not necessarily the total volume but only that part with an absorption coefficient such that the product, $\bar{v} \cdot a$ equaled unity. In other words, any increase in cell dimensions caused by water absorption did not effect a corresponding increase in $\bar{v}$.

This concept of $\bar{v}$ agrees with the development from the rate of production of metabolic substances by an actively growing suspension of bacteria. The equation for the relation between $\bar{v}$ and the rate of production of metabolic substances may be

$$\frac{dM}{dt} = KB\bar{v}, \qquad (7)$$

during the phase of logarithmic growth, or since $B = C'e^{k't}$,

$$m = \int_{t_0}^{t} K' \bar{v} e^{k't} dt.$$

Thus

$$M = K'' \bar{v} e^{k'(t-t_0)}),$$

where

M = quantity of metabolic substances produced between time t_0 and t,
B = change in number of bacteria per ml. between time t_0 and t,
$\bar{v}$ = effective volume per average bacterium,
K'' and k' are constants.

From this it can easily be seen that

(a) Log $M = k_1 t_n + K_1 \bar{v}_n$ for the normal suspension, and

(b) Log $M = k_1 t_x + K_1 \bar{v}_x$ for the irradiated suspension. For equal values of M, subtracting (b) from (a),

$$t_n - t_x = K'_1 (\bar{v}_x - \bar{v}_n). \qquad (8)$$

The condition is imposed that time be counted from the point where the optical

density-time curve for the irradiated suspension departs from that of the normal suspension; in theory $t = 0$ at the time when the suspension to be irradiated is first exposed to the x-rays.

Since M, the quantity of metabolic substances produced, and B, the bacterial count, were both functions of D, the optical density of the suspension, it was possible to apply the relation (8) to the optical density-time curves with acceptable results. The relation (8) was considered applicable as long as the actual bacterial counts of the normal and irradiated suspensions were equal. With $\bar{v}$ for the average normal bacterium equal to 0.75 cubic micra, the $\bar{v}$ calculated from Equation (8) for the average irradiated bacterium was 0.86 cubic micra.

Although the optical density of the growing irradiated suspension increased more rapidly than that of the normal suspension in the logarithmic growth phase, it was found that the maximum optical densities of the two were identical. Thus maximum optical density seemed to be a function of the volume of cell material rather than cell numbers. This was not strange since the irradiated bacteria were apparently undergoing normal development. Also the irradiated suspension entered the phase of negative acceleration sooner than did the normal suspension, an observation which was plausible as long as bacterial numbers remained equal in the two suspensions. This increase in average cell volume of the irradiated bacteria over the normal bacteria could only be interpreted as an increase in active protoplasmic volume, a volume-increase which did not bear relation to that produced by water absorption. Butterfield (4), in observations on the resting phase of bacteria growing in a liquid medium, found that a correlation might exist between the limiting numbers of bacteria which develop in a medium and the size of the individual cells. His work also indicated the existence of a definite relationship between the concentration of the food supply and the limiting numbers of bacteria.

TABLE III.—SPECTROPHOTOMETRIC READINGS AT WAVE LENGTHS 620 mμ AND 700 mμ

Control Suspension			X-rayed Suspension		
Time	D		Time	D	
	620 mμ	700 mμ		620 mμ	700 mμ
0 min.	0.15	0.10	10 min.	0.14	0.10
30	0.19	0.15	40	0.16	0.13
60	0.23	0.19	70	0.22	0.17
90	0.34	0.25	100	0.35	0.28
120	0.48	0.37	131	0.57	0.47
150	0.63	0.50	160	0.79	0.64
180	0.80	0.66	190	1.05	0.91
210	0.99	0.87	222	1.38	1.18
240	1.19	0.99	250	1.58	1.36
270	1.38	1.19	280	1.78	1.65
300	1.57	1.43	311	1.88	1.75
330	1.77	1.61	337	1.98	1.84
360	1.92	1.75	363	2.01	1.90
385	2.00	1.88	388	2.02	2.00

Periods of Irradiation

1. 72nd minute to 99th minute
2. 103rd minute to 127th minute
3. 135th minute to 157th minute
4. 163rd minute to 188th minute
5. 193rd minute to 218th minute

Total exposure.....123 min.
Tube current.....1.2 ma.
Target distance.....9 cm.
Temperature.....26° C.

(The data of Table III are plotted in Figure 3.)

Examination of the data of a number of experiments indicated enhancement of growth and stimulation of metabolic exchanges in the irradiated suspension. The increased activity of the irradiated suspension seemed to be of such a nature as could be produced by a slight increase in temperature suggestive of energy absorption as based upon the Point-Heat Hypothesis. This hypothesis as advanced by Dessauer (5) explained the action of x-rays as the change of absorbed energy into molecular movement. Strangeways and Fell (6), and later Packard (7), pointed out that there was a correlation between the survival of irradiated biologic material and the rate of division after exposure as a function of temperature. A greater percentage of irradiated material survived under reduced metabolism at lower temperatures. In carrying out the experiments outlined in this paper the writer attempted to avoid secondary effects of the x-rays by reducing the temperature for bacterial growth to 25° C.

SUMMARY

A suspension of *B. coli* was irradiated with a specific dosage of x-rays so as to bring about an increase in volume *per bacterium*.

Any change in the optical properties of the irradiated suspension as compared with a normal suspension was measured by means of a spectrophotometer.

During like intervals of the phase of logarithmic growth, the spectrophotometric values of optical density and the actual bacterial total counts of a suspension bore a constant relation to each other, such that

$$B = C\left[\frac{I_0}{I}\right]^k.$$

The total volume per average normal bacterium was measured under the microscope, and found to be 0.75 cubic micra; the total volume per average irradiated bacterium was measured in a like manner, and found to be 2.00 cubic micra.

The swelling of the irradiated bacteria was divided into two components: (1) enhanced growth, or increased protoplasmic volume; (2) swelling caused by water absorbed from the medium.

Assuming the absorption coefficient of the irradiated suspension to be equal to that of the normal suspension, it was possible to calculate the effective volume per average irradiated bacterium, *i.e.*, the total volume minus the volume attributed to water inclusion. This calculation was restricted to the phase of logarithmic growth when the bacterial counts of the two suspensions were equal.

The effective volume per average irradiated bacterium was calculated for one experiment (Table I) to be 0.85 cubic micra by one method, and 0.86 cubic micra by another; the effective volume per average normal bacterium was assumed to be equal to the total volume, *i.e.*, 0.75 cubic micra.

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A SIMPLIFIED MECHANICAL METHOD FOR RADIOGRAPHIC MENSURATION AND LOCALIZATION[1]

By H. E. KIMBLE, M.D., Surgeon, Baltimore & Ohio Railroad, *Chicago*

THE radiographic mensuration of anatomical structures and the localization of foreign bodies are two things the roentgenologist is frequently called upon to do, and for the performance of such work numerous methods have been devised. Former methods have not been wholly satisfactory because of the complicated technic and mathematical computations involved. A method which is simple, accurate, rapid, and which is free of all mathematical computation has long been desired by roentgenologists. Such a method has been devised and is described herein.

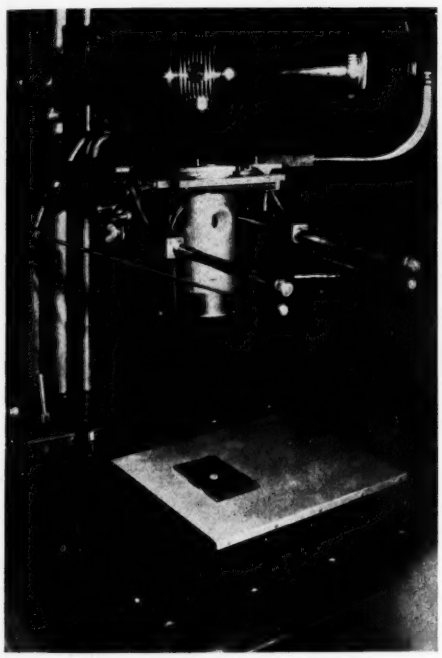

Fig. 1. The periscope replaces the cone in the tube carriage. A mirror with a hole and a marker in the center is placed on the cassette.

In order to do either mensuration or localization by this procedure it is necessary to know only three things:

1. The anode-film distance
2. The tube-shift distance
3. The point at which the projected rays strike the film perpendicularly.

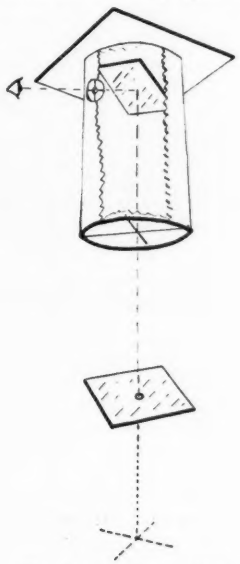

Fig. 1-*A*. The construction of the periscope and the mirror.

The first two are obtained directly from the scales on the x-ray apparatus and the third is found quickly with a periscope and a mirror. The periscope (Fig. 1) is an aluminum tunnel approximately two inches square and eight inches in length. To one end of the tunnel is attached a metal base similar to the base of an x-ray cone. Near the top but inside the tunnel a mirror is placed at a 45° angle. There is an opening about one inch in diameter in the wall of the periscope opposite the face of the mirror. This opening contains two guide lines crossing one another at right-angles. A similar pair of lines is contained in the lower end of the tunnel.

[1] Clinical demonstration given at the Annual Meeting of the Radiological Society of North America, Dec. 3-7, 1934.

The mirror to be used in conjunction with the tunnel periscope (Fig. 1) is three inches square. In the center is a hole one-eighth inch in diameter and around this hole a white marker one-half inch round.

The periscope and mirror are used only in the making of the radiographs. To read the radiographs a mensuration table and ruler are needed.

The mensuration table consists of a horizontal view box with an upright post attached at one side. This post carries two horizontal rods which extend to the center of the view box. Clamps make possible the fixing of these rods at any desired height above the mensuration table, which is the surface of the view box. The distal ends are called pseudo-targets and represent the target of the x-ray tube in its two positions. Figure 2 shows the two pseudo-targets attached to a single arm which permits horizontal placement of the targets at any desired height above the table. To one pseudo-target is attached two white strings and to the other two black strings. The strings are held taut by means of weights.

A transparent ruler commonly called a "transparule" is used to measure the desired distances as reconstructed on the mensuration table.

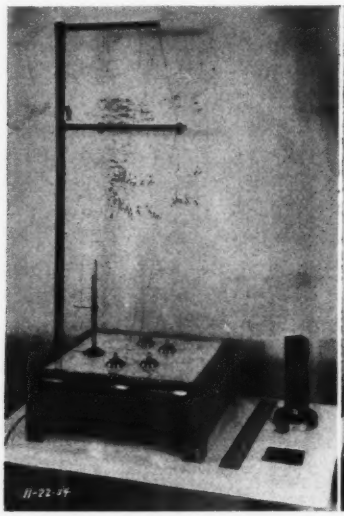

Fig. 2.

Fig. 2-*A*.

Fig. 2. A mensuration table with pseudo-targets adjusted to the horizontal shift.

Fig. 2-*A*. A mensuration table with pseudo-targets adjusted to the vertical shift position.

Making the Radiograph.—Select any convenient point on the film holder, cassette, or flat-top Bucky diaphragm. If a curved-top Bucky diaphragm is used, select a point on a line which bisects the diaphragm. Place the center of the mirror over this point. Raise the tube carriage to 20, 25, 30, or 35 inches above the film, depending upon the requirements of radiography. Place the periscope in the tube carriage and adjust it until the two sets of guide wires, the center of the mirror, and the reflected guide wires are in line (Fig. 1-A). Make a mark on the cassette through the hole in the mirror. Remove the mirror and place a metal marker on this mark. Place the patient or object to be measured in the usual position for taking an ordinary radiograph. If a one-film, double-exposure technic is used, the

film is under-exposed about one-third. After the first exposure the tube is shifted in any convenient direction by means of

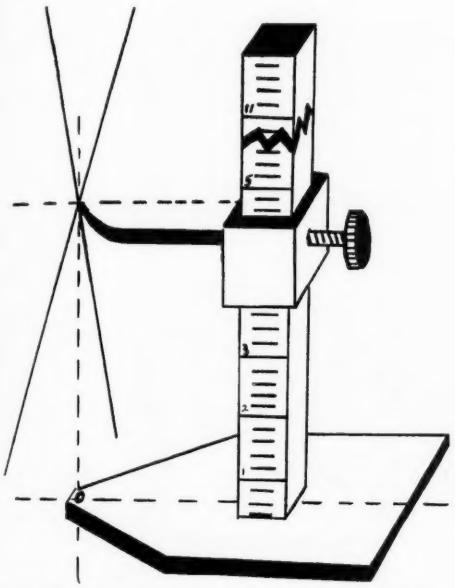

Fig. 3. This measuring gauge locates the point on the film directly below the two cross lines. This distance is also read directly from the scale.

the adjustments provided on the machine; if vertically, 5 or 10 inches, if horizontally, a multiple of one inch but not more than 15 inches. Then re-expose. When the shift is made in the vertical direction, proper correction should be made in the length of exposure time to obtain the same density of radiographs for the two positions.

When a Bucky diaphragm is used the shift of the tube carriage between exposures is either in the longitudinal or vertical direction. If no Bucky diaphragm is used, the shift may be in a longitudinal, lateral, or vertical direction. If radiographs are made with the films on an angle, the shift must be lateral.

Reading the Radiograph.—The finished film or films are so placed that the mark indicating the point where the perpendicular ray strikes the film on the first exposure is directly over the center of the view box. A pseudo-target is located directly over this mark at the height of the true target when the first exposure was made. The

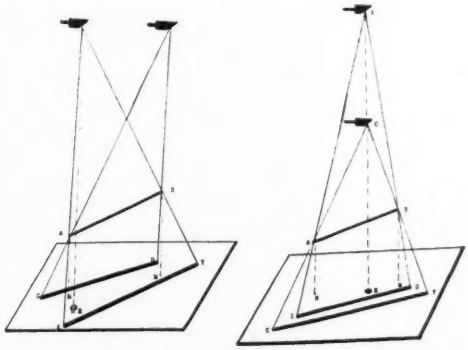

Fig. 4. These diagrams show the paths of the rays when the tube is shifted either horizontally or vertically.

strings from this pseudo-target are so placed that they extend directly from the pseudo-target to the extremities of the image. Likewise the second pseudo-target is so adjusted that it holds the same relative position as the true target held during the second exposure. The strings from this pseudo-target are similarly extended to the ends of the second image. Two points are established where the white lines cross the black lines: these two points indicate the position of the object and the distance between the points its length. A ruler held between these two points indicates the length directly. A ruler held perpendicularly to the film from either intersection indicates the distance of this point from the film. In localization, this distance represents that between the film and the corresponding point in the foreign body. A measuring gauge (Fig. 3) with a special base is designed for this use.

The Basis of the Method.—The basis of this method is mechanical correction of distortion, the greater the distortion the more accurate the method. For explanatory purposes let A B (in Fig. 4) be any object *not* parallel to the film and whose length we wish to determine. E is the point where the perpendicular ray from

the target O strikes the film, as found with periscope and mirror. On first exposure $C\,D$ represents the distorted

Fig. 5. These two superimposed radiographs of a female pelvis were taken at a distance of 30 inches with a 4-inch shift. The mark X shows where the perpendicular ray passed through the patient.

or magnified shadow of $A\,B$. X represents the position of the target on the second exposure. $Y\,Z$ is the distorted shadow of $A\,B$ on the second exposure. $A\,N$ and $B\,M$ represent the distance of the ends of the object $A\,B$ from the film.

After the radiographs are made, according to the technic given above, the paths of the rays are reconstructed on the mensuration table. The desired distances $A\,N$ and $B\,M$ may then be measured directly with a ruler.

CLINICAL APPLICATION

Pelvimetry.—The internal measurements of a pelvis can be obtained readily by this method. The fact that the pelvic inlet plane is at an angle of 30 to 35 degrees with the film makes no difference. The technic is similar to that used in making stereoradiographs of the kidney area.

In pelvimetry it is desirable to make the radiographs during the first trimester of pregnancy for two reasons: first, the patient is not subjected to long exposures; second, measurements of the fetal head near the end of the third trimester can be obtained better by different positioning and shifting the tube than that recommended for pelvimetry.

The tube is centered by means of the periscope so that the perpendicular ray will strike about four inches from the top of the film. The patient is then placed so that the perpendicular rays will pass through the line joining the iliac crests. The tube is then shifted two to four inches to the left at the desired height 20 (25, 30, or 35 inches) before the first exposure is made. Before the second exposure the tube is shifted the same distance to the right of its original or perpendicular position.

Figure 5 shows two superimposed radiographs of a female pelvis taken at a distance of 30 inches with a 4-inch shift, 2 inches to each side of the perpendicular position.

When the radiographs are placed on the mensuration table the desired distance between any two points can be readily

obtained by following the procedure already described.

The following distances are usually desired:

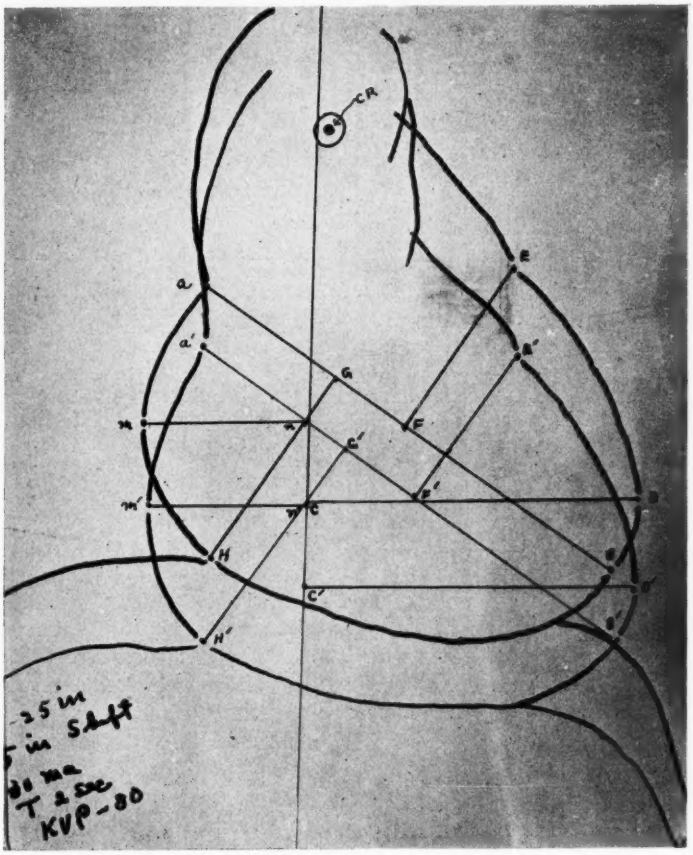

Fig. 6. A tracing made from two superimposed radiographs of the heart. These radiographs were made at a 25-inch distance, with a 5-inch shift. The exposure time was 2 seconds.

1. That from the promotory of the sacrum to the nearest inner surface of the symphysis;
2. The internal right oblique;
3. The internal left oblique;
4. The bi-spinous.

Fetal Cephalometry.—In many cases it is desirable to perform x-ray cephalometry at the end of the third trimester of pregnancy. The position of the fetal head at this time will determine the position and shift of the tube. It is obvious that the shift of the tube should be made as nearly at right-angles to the diameter which the operator wishes to ascertain with the greatest accuracy. If this is not practical, the vertical shift can always be resorted to. Usually the first exposure is made at a 25-inch distance and the second at a 35-inch distance. The perpendicular ray is directed somewhere below the pelvic brim. If the fetal position is occiput right anterior or occiput left posterior, the perpendicular ray should strike the patient in the left inguinal region. For occiput left anterior and occiput right posterior, the perpendicu-

lar ray is directed to the opposite inguinal area.

Fetal cephalometry is reliable only if one can identify certain landmarks of the fetal skull on the radiograph. It is also important that the fetus does not move between exposures—if the fetal head is engaged there is little danger of motion.

Heart (Cardiography).—The measurement of the size of the heart is simplified by this device. Two exposures of the chest at a distance of 25 inches or more with a 5-inch shift give excellent radiographs. Figure 6 shows a tracing made from two superimposed radiographs of the heart. The time of exposure is lengthened so that the heart beats through one complete cycle. This makes it possible to obtain always the largest diameter during diastole. Table I gives the important standard measurements.

TABLE I[2]

(ABBREVIATED)

HEART MEASUREMENTS ACCORDING TO DIETHEN

Age	Height cm.	Weight kgs.	T.D. cm.	L.D. cm.
Up to 15 years	100–110		8	8.5
	110–120		8.8	9.2
	120–140		10	11
Men	150–160	40–50	12	13
	160–180	50–75	13	14
	180	75	14	15
Women	145–155	40–50	11	12
	155–165	50–60	12	13
	165	60	13	14

[2] From Recent Advances in Radiology, Peter Keeley. P. Blakeston's Son & Co., Philadelphia, 1931.

Radiographs taken at a later date for comparison need not be made at the same distance or shift. A slight rotation of the patient makes no difference in the end-results. The only requirement is that the patient must be in the same (upright or supine) position as when previous measurements were made.

Table II is presented to show that a wide variation exists between measurements made in the two different positions.

From this table one concludes that there is a definite relation in 80 per cent of the cases of cardiac length to body length with the patient supine, and only 59 per cent when the patient is in the standing position.

Foreign Body Localization.—This method is ideal for the localization of foreign bodies which are opaque to the x-ray. A foreign body can be localized either from the anterior, posterior, or lateral surfaces of the body in which the object is located. It can also be localized from one or more points on the same surface.

TABLE II[3]

(ABBREVIATED)

	Position	Value	Number of cases in the range 95–106, 100 being taken as representing mean value
Heart length	Lying	0.0839	80
Body length	Standing	0.0755	59
Heart width	Lying	0.0639	74
Body length	Standing	0.0573	58
Heart length	Lying	1.32	63
Heart width	Standing	1.32	52
Heart length lying over Heart length standing	From lying to standing	1.12	75
Quotient body length over transverse diam. of the thorax	Lying	6.50	72
	standing	6.84	70

[3] From abstract of L. Moritz article in General Medicine (Practical Medical Series), 1932, page 618. Year Book Publishing Co., Inc., Chicago.

The tube is centered and the perpendicular ray point marked on the film holder. Two or more small lead markers are placed on the patient in the neighborhood of the foreign body. The exposures are made at any convenient height and shift. Two exposures can be made, usually on one film.

After the film is placed on the mensuration table two of the cross lines are used to mark the location of the foreign body, while the other two show the position of the lead marker on the surface. The location is then mapped out on the patient's body. Figure 7 shows the location of a foreign body in the thigh of a patient.

Nearly all other uses of mensuration or localization fall under one of the groups described above. A number of other measurements which may be determined with a remarkable degree of accuracy are:

(*a*) The size of abscessed cavities and tumors of the lung.

(*d*) Width of the facial bones. (Very important before sphenoidectomy.)

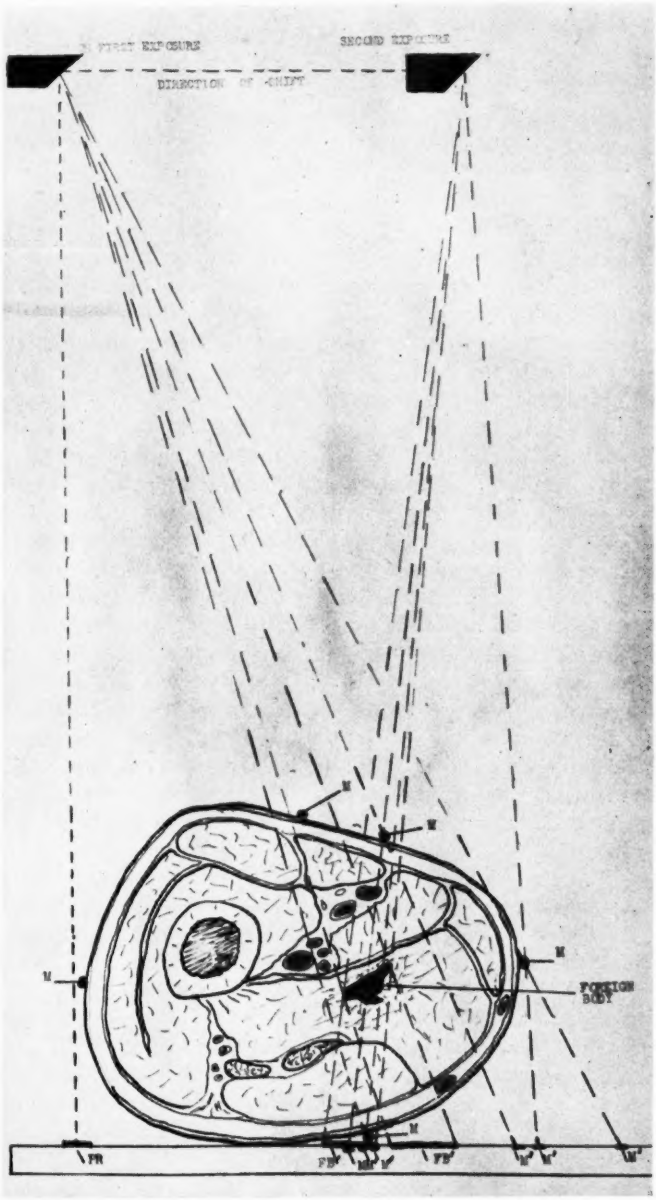

Fig. 7. The localization of a foreign body in the thigh of the patient. The marks *M* are markers on the surface of the thigh, any one of which can be used as a landmark.

(*b*) The width of the sella turcica.

(*c*) Whether impacted teeth are lingual or buccal.

(*e*) The shortening of bones from the overlapping of fragments.

(*f*) Distance between fragments of bone.

(*g*) Width of thymus gland.

(*h*) Size of internal tumors under treatment.

(*i*) Depth of objects like kidney stones, gallstones, etc.

(*j*) Foreign bodies in the eye.

CONCLUSIONS

1. A universal method is presented which can be applied to the entire field of mensuration and localization in radiography.

2. It is simple, accurate, and free of all mathematical computations.

3. The apparatus required can be attached to any x-ray equipment now in use.

7854 South Ashland Ave.

DIVERTICULA OF THE FUNDUS OF THE STOMACH[1]

By L. W. PAUL, M.D., *Madison, Wisconsin*

Assistant Professor of Radiology, University of Wisconsin Medical School

AS COMPARED with other portions of the gastro-intestinal tract, particularly the colon and duodenum, diverticulum of the stomach is usually considered as a relatively rare condition. Tupper (1), who reviewed the literature in 1923, could find only 37 cases described and to these he added one of his own. He credited the original description to Helmont, in 1804, but most of the cases have been reported since the use of roentgen rays, particularly during the past twenty years. Likewise, Nauwerck (2), in a review of the material from about 15,000 autopsies, could find but two cases, and other writers comment on the extremely infrequent occurrence of this condition. As with other supposedly rare lesions it is probable that many cases have been diagnosed by radiologists but have never been reported. At a meeting of the x-ray section of the Wisconsin State Medical Society, in 1931, when this subject was up for discussion, Dr. Frank Mackoy, of Milwaukee, stated that he had records of twelve cases and several other radiologists present had each seen one case. To my knowledge, none of these have been published. It is very likely, therefore, that the reported cases represent only a portion of those diagnosed. In the diagnostic x-ray section of the Department of Radiology of the University of Wisconsin, six cases of gastric diverticula have been observed. During the four years in which these were seen, approximately 5,000 patients have been examined by means of a barium meal. This gives an incidence of 0.12 per cent, or slightly more than one case per thousand. During this same period four cases of Zenker's pharyngo-esophageal diverticulum have been observed, giving some idea of the relative frequency of these conditions as found in this clinic.

[1]From the Department of Radiology and Physical Therapy, University of Wisconsin; Chairman, Ernst A. Pohle, M.D., Ph.D., Professor of Radiology.

CLASSIFICATION AND ETIOLOGY

As with diverticula elsewhere, those occurring in the stomach may be classed as either true or false. The true diverticulum consists of an out-pouching of the gastric wall and contains all of the coats of the stomach, although these may, at times, be considerably thinned out. The false diverticulum consists of a herniation of one coat through a tear or hole in another, usually the mucosa through the muscularis. One may also consider diverticula as being either of congenital or acquired origin. The latter might be of either the traction or pulsion type.

In a majority of the reported cases the location has been in the cardiac end of the stomach, practically all of these having occurred on the posterior wall near the cardiac orifice. In the remaining cases, the location has been in various parts of the body and antrum of the stomach, there being no particular site of predilection. In this latter group are cases due to hair balls or other foreign bodies in the stomach, traction diverticula due to adhesions, a few with myomas in the walls, and a few showing remnants of pancreatic tissue. The etiology of this last group is uncertain but they may be congenital. Pseudo-diverticula, the result of ulceration or operative procedure, may also be put in this general group. It appears, then, that those occurring on the posterior wall of the fundus are a distinct entity and probably have an etiology peculiar to them alone.

The earlier writers on the subject usually considered all gastric diverticula as being of congenital origin. One reason cited was the fact that in some of the lower

animals, especially the pig, a diverticular-like out-pouching of the fundus was of frequent occurrence and was to be considered normal. Also, as Keith (3) observed, the stomach itself develops as a diverticulum of the foregut. However, in recent years the opinion seems to have changed and, as pointed out by Bell and Golden (4), most observers now subcribe to the view of an acquired origin. This is explained on the basis of a structural weakness of the stomach wall at this point since, as stated above, most of these diverticula develop on the posterior wall of the fundus. Kalbfleisch (5), in reporting a case, elaborated on this feature. He states that anatomically the longitudinal muscle fibers, as they extend toward the cardia, tend to divide into the two following main courses: one spreading over the fundus and running along the greater curvature; the other bundle following the lesser curvature. Likewise, the circular coat, while, being thick and abundant at the pylorus, tends to become thinned out over the fundus. The oblique layer is also thin in this area. In addition, large blood vessels enter the stomach wall at this point causing further structural weakness in the muscular coat. Kalbfleisch compares this area to that in the posterior wall of the pharynx where Zenker's di-

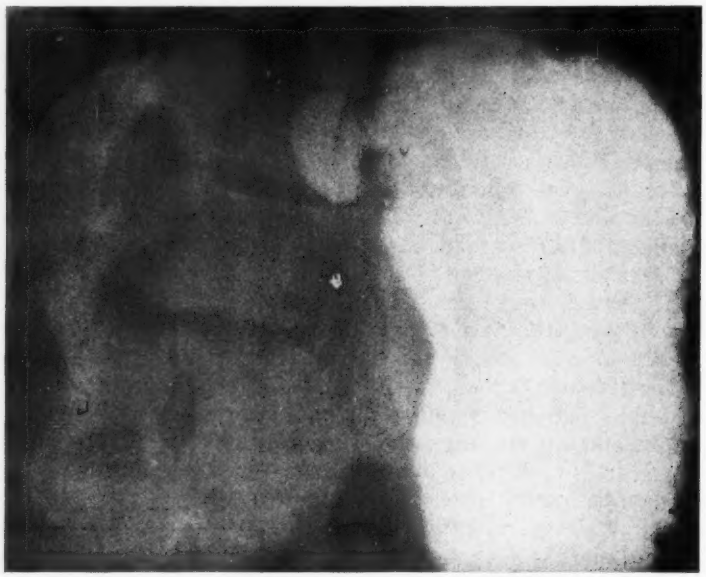

Fig. 1. Case 1. Typical shadow of barium-filled diverticulum. Note narrow neck connecting pouch to stomach.

verticula always appear. It is also pointed out that this portion of the fundus undergoes the greatest strain when food enters from the esophagus. This strain would be aggravated by any increase in intra-gastric pressure either from disease at the pylorus or from reflex spasm. Laurell (6) has a different theory. He believes them to be pulsion diverticula and sees as an essential factor in their formation the intra-abdominal downward pressure which takes place in the upper part of the abdomen when the body is in the upright position. Of 34 cases reviewed by him, 28 occurred in middle aged or older women, and the slack abdominal wall so often seen in these persons was thought to be a factor. This preponderance of females to males is not apparent in the series reported in this paper, there being four males and two females. It is possible that various causative factors enter in different individuals but the most

logical theory at the present time seems to be that which presupposes a point of weakness in the gastric wall as the first essential. The other factors of increased intra-gastric pressure, downward abdominal pressure, etc., may operate secondarily in some cases.

DIAGNOSIS

1. Symptoms.—The symptomatology is varied. In many cases no symptoms referable to the stomach were present and the diverticulum was found during a routine gastro-intestinal examination. In others, the chief complaint was discomfort in the epigastrium, made worse by eating and relieved by vomiting. There is, however, no constancy in the symptoms: very often other pathologic conditions are found and when these are remedied the symptoms disappear (Case 6). In only one of the cases observed by us has there seemed to be any relationship between the diverticulum and the symptoms complained of by the patient (Case 4). Several cases have been reported in which carcinomatous degeneration was found at the base of the diverticulum. Moore (7), in a discussion of diseases of the cardiac end of the esophagus and stomach, makes the statement that in a considerable proportion of the gastric diverticula operated upon at the Mayo Clinic cancerous tissue has been found at the tip, but he does not state the number. This fact should be borne in mind, however, in evaluating the symptoms.

2. X-ray Findings.—The diagnosis, then, is dependent during life upon the roentgenologic examination. This should be relatively easy providing a careful examination is made which includes fluoroscopic observation in the upright and recumbent positions in all diameters. The characteristic finding is that of a rounded or oval shaped pouch with smooth margins connected to the stomach by a narrow neck. The most common location is on the posterior wall of the fundus several centimeters lateral to the cardiac orifice. If the pouch is only partially filled, a fluid level may be seen in the upright position. With the patient in a supine position and rotated slightly to the left, the typical pouch will be seen to best advantage. In this position, the fundus remains full of barium, the diverticulum is dependent, and some of the opaque substance should enter even though the pouch may be filled with fluid, due to the tendency of barium to sink because of its weight. Barium is often retained at the end of six hours or longer, while the balance of the stomach is empty. Films taken in the horizontal position will show a smoothly rounded, sharp shadow. This finding led to the correct diagnosis in Case 3.

The fact that a diverticulum is not found at operation after being diagnosed roentgenologically does not necessarily mean that the diagnosis was incorrect. Due to their high location and position on the posterior wall, direct visualization is difficult and the opening of the pouch may be so small and hidden in the mucosal folds that it can easily be missed both by the eye and the examining finger, even when the stomach has been opened.

DIFFERENTIAL DIAGNOSIS

From the standpoint of differential diagnosis, a diverticulum must be distinguished from the niche of a penetrating ulcer. If the diverticulum is small this may be difficult, however, ulcers seldom occur in as high a location as diverticula commonly do. They do not show the bulbous sac and narrow neck but are more often rounded, pointed, or irregular, and frequently show spastic manifestations locally or at the pylorus, something that true diverticula do not. Herniation of the stomach through the esophageal hiatus or other parts of the diaphragm must also be considered but may be eliminated by demonstrating that the pouch is below the diaphragm. Diverticulum of the lower end of the esophagus may be ruled out by showing that the pouch has no connection with the esophagus. Pendergrass (8) calls attention to the fact that a diverticulum is larger on inspiration than on expiration, while the opposite is true of a hernia, and that the optimum position for visualizing

Fig. 2. Case 2. An illustration of the usual contour of this type of diverticulum. Patient in a supine position with right side elevated about 45°. This case is similar to Case 1.

Fig. 3. A six-hour film. The arrow points to the barium residue in the diverticulum, with the balance of the stomach empty. This is a common finding.

a diverticulum is in the recumbent left oblique posture while a hernia will be best seen in a postero-anterior recumbent or in the Trendelenburg position.

CASE REPORTS

Case 1. A white male, aged 49 years, was first examined on July 28, 1931. He complained of pain and soreness in the center of the epigastrium which had been present for one week. Similar attacks but not as severe, had occurred intermittently during the past year. The pain was fairly constant, with some increase in severity two to three hours after meals. In recent months he had had considerable worry over financial matters and tended to blame his stomach trouble on his worried mental state. Physical examination revealed nothing of importance except diseased tonsils and a slightly enlarged postate. X-ray examination of the stomach revealed a typical diverticulum of the fundus of the stomach. Otherwise, the gastro-intestinal tract was normal. The patient later had a flare-up of symptoms of which the neurotic element predominated and he was hospitalized for treatment of the psychoneurosis.

Case 2. W. K., a white male, aged 27 years, was admitted to the hospital on Nov. 6, 1931, his chief complaint being that of a pain in the left leg since the previous July. He stated that for the past four years he had had attacks every summer of dull epigastric pain, coming on about an hour after meals and associated with nausea. Food usually gave relief. At the time of hospitalization there were no abdominal complaints. The condition in the leg was diagnosed as a sciatic neuritis. X-ray examination of the stomach revealed a diverticulum of the fundus. Otherwise, no pathology was found in the gastro-intestinal tract.

Case 3. Mrs. D. L., aged 35 years, had been seen on several occasions in the Student Health Clinic where a diagnosis of

rheumatic heart disease with adherent pericardium had been made. Two and one-half years previously she had had a severe attack of pain in the right upper quadrant associated with vomiting. Two similar attacks had occurred since then. Because of this history and for the purpose of a complete physical examination an intravenous gall-bladder test was done. The concentration response was reported as being sub-normal, but without evidence of calculi. Gastro-intestinal examination showed nothing abnormal except that in the film made at six hours a small round fleck of barium was seen in the region of the fundus. This aroused a suspicion of gastric diverticulum and the diagnosis was proved at a second examination.

Case 4. C. W., female, aged 43 years, was first admitted to the hospital Dec. 28, 1928, at which time a diagnosis of chronic catarrhal colitis, spastic type, was made. There were no symptoms referable to the stomach. She was re-admitted on Dec. 29, 1932. There had been little improvement in the bowel symptoms. She had severe constipation and colicky pains in the lower abdomen, which were relieved by enemas. She complained of a burning pain beneath the sternum, of four months' duration. There were two distinct areas to which the pain was referred, one high up in the esophagus and the other at the level of the xyphoid process. The pain was present only on swallowing, the patient stating that it felt as if something was obstructing the passage of her food. For the last six months she had spat up at irregular intervals small amounts of bright red blood, never as much as a teaspoonful. Gastro-intestinal x-ray examination revealed a typical diverticulum of the gastric fundus; the patient localized the lower point of pain as directly over this. No other lesions were found in the upper gastro-intestinal tract.

Case 5. C. O., white male, aged 55 years, was admitted to the hospital on Dec. 26, 1932. The chief complaint was epigastric pain. Two years previously there had been a sudden onset of momentary dizziness upon suddenly arising, also, a dull aching pain in the epigastrium. The pain, which was never very severe, became worse when the man was hungry and was relieved for two to three hours after taking food. There was no night distress. The clinical findings led to the diagnosis of arteriosclerotic cardiovascular disease, myocardial degeneration, relative mitral insufficiency, aortitis, and emphysema. X-ray examination of the stomach showed a diverticulum of the fundus. The gall bladder revealed a normal function after the oral dye test. The abdominal symptoms were thought to be due to the well marked cardiac pathology.

Case 6. C. H., white male, aged 48 years, whose chief complaint was "gas in the stomach." He had been operated upon eighteen years previously for ulcer. About ten years ago he began having a recurrence of pain, although not severe. Eight years ago he vomited a large amount of blood. Since then he has had intermittent pain after meals, relieved by food, and much gas. Three weeks previous to admission he had suffered a severe attack of diarrhea and the pain was more intense, but this attack had largely subsided. Gastro-intestinal x-ray examination revealed a gastro-colic fistula and a small diverticulum of the fundus of the stomach. The patient was operated upon and the fistula repaired. No attempt was made to find the diverticulum. The patient recovered and was discharged, greatly improved. This is the only case in the series in which disease was found elsewhere in the stomach which might have affected the intra-gastric pressure. In none of the other five cases was there any evidence of obstructive lesions or spasm at the pylorus.

SUMMARY

1. Six cases of diverticulum of the fundus of the stomach are reported with brief case histories.

2. The etiology is uncertain. The most logical assumption is that these are pulsion diverticula due to an inherent

weakness of the gastric wall at this point, possibly coupled with other mechanical factors such as strain on the gastric wall from food entering from the esophagus and increased intra-gastric pressure in some cases.

3. The symptomatology is varied and in many cases the condition is probably asymptomatic. In only one of the cases reported in this paper did there seem to be a definite connection between the symptoms complained of and the diverticulum.

4. The roentgenologic and differential diagnoses are discussed.

5. The importance of recognizing these lesions lies chiefly in the necessity of differentiating them from other and possibly more serious conditions.

Note.—Since submitting this paper for publication, another case of gastric diverticulum has been observed. The x-ray findings were similar to those illustrated. The patient was operated upon and the diverticulum resected. A badly diseased gall bladder was also found and removed.

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BASOPHILIC ADENOMA (PITUITARY BASOPHILISM)

REPORT OF A CASE, WITH CLINICAL IMPROVEMENT OF SYSTEMIC MANIFESTATIONS AFTER IRRADIATION OF THE PITUITARY

By MICHAEL G. WOHL, M.D., JOHN R. MOORE, M.D., *and* BARTON R. YOUNG, M.D., *Philadelphia*

From the Departments of Medicine, Orthopedic Surgery and Radiology, Temple University Medical School

IT WAS Erdheim (I) who first called attention to the existence of basophilic adenoma; however, it remained for Cushing to bring to light the clinical significance of these tiny lesions of the pituitary and to reconstruct a clinical entity which is best known as Cushing's basophilism. For the full story of the disease one needs necessarily to consult the writings of Cushing (2).

Pituitary basophilism as defined in Cushing's writings (3) is characterized by a rapidly acquired obesity which affects chiefly the face, neck, and trunk; hypertension, demineralization of bones of the skeleton, and purplish striæ of the abdomen are additional characteristic features of the disease. In women, hirsutism and amenorrhea are commonly observed. It is to be emphasized that without a postmortem verification, the diagnosis of the malady may be questioned. It may be confused clinically with hyperadrenalism of the cortical type and in some instances it has lead to an exploration of the adrenal gland. The clinical features and the progress of the disease in the patient who has been under our observation at the Temple University Hospital were so strikingly characteristic of "basophilism" that it appeared justifiable to place the case on record even though the diagnosis has not been verified by postmortem.

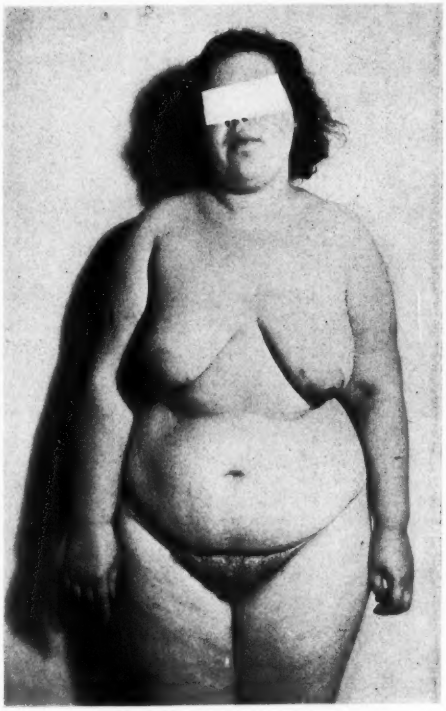

Fig. 1. J. W., pituitary basophilism (unverified), showing adiposity (chiefly abdominous), striæ, and hirsuties.

CASE REPORT

Miss J. W., age 23 years, single, white female, came to the Temple University Hospital because of pain in the lower third of the right tibia and right foot and ankle, and rapid gain in weight (having gained twenty-five pounds in the past nine months). She was also bothered with swelling of both ankles. The pain in the right lower extremity had commenced three years before admission and gradually became worse. At first the pain was limited to the right foot and then extended to the ankle and lower right tibia. The pain was of a dull, aching character, aggravated by walking or standing.

In addition to the above mentioned pain, she complained of stiffness and pain in the left knee, of much milder degree. The swelling of the ankles was of nine months' duration, always worse toward evening. About eight months after the onset of the

Fig. 2. Rather large defects can be seen in the first, third, and fourth metatarsal bones and in the first terminal phalanx. This film was made shortly after admission and before x-ray treatment.

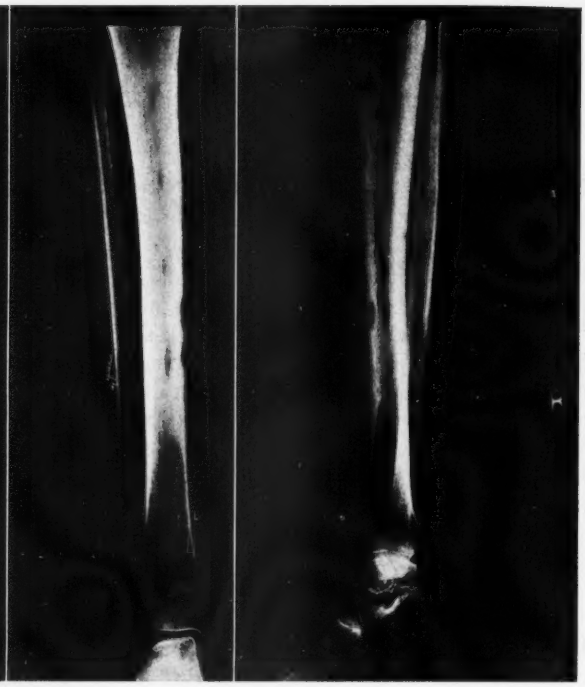

Fig. 3. The sharply circumscribed defects in the tibia can be seen throughout the shaft of the bone. Roentgenograms made before treatment.

illness there developed a "soft tissue tumor" on the right ankle and another similar tumor appeared a few months later on the calf of the right leg. Both of these tumors were removed and found to be lipomas.

During the past year she had developed shortness of breath, a growth of fine hair on the upper lip and the under-surface of the chin, and on two occasions dizzy spells that lasted three days. She noticed a steady, progressive gain in weight, having gained twenty-five pounds in the past nine months. Her past history is irrelevant except that she had the customary diseases of childhood and also suffered from sore throats for many years. Her menses started at the age of twelve, lasting seven days and accompanied by considerable dysmenorrhea. In the past fourteen months the menstrual flow had become scant and the periods irregular.

Physical examination showed an obese, sluggish young woman, 5 feet 4 inches in height and 232 pounds in weight. The face was round and the site of an old acne with considerable scarring and pitting. There was a thin growth of hair on her upper lip and chin. The obesity was of generalized distribution but predominated over the hips, abdomen, and thighs, while her legs and arms were disproportionately thin for her face and trunk. The breasts were pendulous. The skin was dry and there was a growth of hair from the symphysis pubis to the navel. On both lateral and anterior aspects of the lower half of the abdomen prominent purplish striæ were present.

Examination of the heart and lungs revealed no abnormalities. The blood pressure varied from 155/85 to 140/90. The pulse rate ranged from 80 to 100. Examination of the eyes showed that the vision

in the right and left eyes was 20/30. Examination of the visual fields by the campimeter revealed a sector-like constriction in the right upper temporal field and slight constriction in the left upper temporal quadrant. The fundi and media were normal.

The basal metabolic rate was minus 26 per cent. She had a high tolerance for carbohydrates. Oral administration of 100 grams of glucose caused a rise in blood sugar in one hour to 114 mgm. per 100 c.c. of blood, but this figure dropped to 105 mgm. at the end of the third hour. The blood cholesterol was 180 mgm. per cent. The blood calcium was 11.5 mgm. per cent and blood phosphates 4 mgm. per cent. The results of the blood count were: hemoglobin, 13 grams; red blood cells, 4,550,000; leukocytes, 9,050; neutrophils, 50 per cent; eosinophiles, 2 per cent; monocytes, 2 per cent; lymphocytes, 46 per cent. The Wassermann test was negative. The urine contained a trace of albumin; no formed pathologic elements were found microscopically.

X-ray examination of the right foot showed areas of rarefaction in the metatarsal bones and phalanges (Fig. 2). X-ray examination of the right leg showed similar areas of rarefaction in the tibia (Fig. 3). Roentgenograms were made of the ribs, dorsal and lumbar spine, and the skull, but these portions of the bony skeleton were normal. The sella turcica was entirely normal in size and shape.

Course of the Disease.—The patient was placed on a diet of 1,500 calories. Desiccated thyroid was given three times a day, the dose at first being one-half grain, increased to one grain. During two weeks of treatment she lost about five pounds in weight, the pains in the legs and dizziness were still present, and the feeling of not being "quite well" persisted. The basal metabolic rate rose to minus 17 per cent. The blood pressure remained on the same level as when she was first examined. She was given a series of x-ray treatments: 250 r to each side of the cranium at the first visit and 100 r at weekly intervals thereafter, until six treatments had been given in all. The exact position of the sella turcica was determined by roentgenograms and fluoroscopy of the skull.

Fig. 4-*A*. Roentgenogram made nine months after a series of x-ray treatments to the pituitary gland. The demineralized areas in the tibia are so completely filled in by new bone that their original sites are difficult to determine. See also Fig. 4-*B*.

Her general condition promptly improved—the blood pressure decreased;

the pain in the right lower extremity markedly diminished; her weight rapidly went down to 215 pounds (on the day treatment was commenced, weight was 225 pounds). Roentgenograms of the right foot and right leg, made two months after the completion of the series of x-ray treatments, showed that the areas of rarefaction had become much smaller due to filling in of new bone. Mineralization was so marked that the bone appeared quite dense. A recent roentgen examination of the right foot and leg (11 months after the original examination and 9 months after the x-ray treatments to the pituitary) shows scarcely any defects in the bones (Figs. 4 and 5). Her menstruation became regular and of normal flow. The patient was discharged from the hospital and is attending the Endocrine Clinic. On her last visit, her weight was 187 pounds and she had no subjective complaints.

Fig. 4–*B*. See caption of Fig. 4-*A*.

Fig. 5. Roentgenogram of the right foot nine months after x-ray treatment. Note that the rarefied areas have been replaced by new bone.

SUMMARY

To summarize the clinical picture of the case, we find a young obese woman with a moderately elevated blood pressure who presented herself to the clinic because of pain in the right lower extremity and edema of both ankles. In addition, she showed hirsutism and scanty, irregular menstruation. The outstanding positive laboratory findings were decalcification of bones of the lower extremity, low basal metabolic rate, and increased carbohydrate tolerance.

The visual fields were found to be moderately contracted.

A series of roentgen treatments to the pituitary gland brought about deposition of lime salts in the demineralized bones and a striking improvement in the patient's general condition. That the patient showed a polyglandular syndrome is evident. Without a postmortem verification it is hazardous to state which gland was chiefly responsible for the endocrinological signs. However, the fact that irradiation of the pituitary gland brought about not only calcification of the osteoporotic bones, but also improved the patient's general condition would induce one to favor the pituitary gland as playing the primary rôle in the patient's malady.

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IDEM: Arch. Int. Med., 1933, **51,** 487.

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THE MANAGEMENT OF THE PRODUCTIVE LESION IN PULMONARY TUBERCULOSIS[1]

A STUDY OF 500 CASES

By C. C. BIRKELO, M.D., *and* S. M. GELENGER, M.D., Herman Kiefer Hospital, *Detroit, Michigan*

IN THE past few years we have witnessed some marked changes in the treatment of pulmonary tuberculosis. The application of surgery in this field has become more and more common and to-day it would be almost impossible to begin the treatment of any case of pulmonary tuberculosis without having in mind some surgical procedure. The hopelessness of long-continued bed rest has at last been well nigh universally accepted and a definite attempt has been successfully made to shorten the period of needed hospitalization in all cases, but especially in the chronic types of the disease. In some sections the new idea has been accepted with open arms and in other places, with some reluctance. Attempts at standardization of treatment to be used here is just as difficult as in any other field of medicine. The individual patient presents a problem all of his own which must be solved before the most successful measures can be instituted.

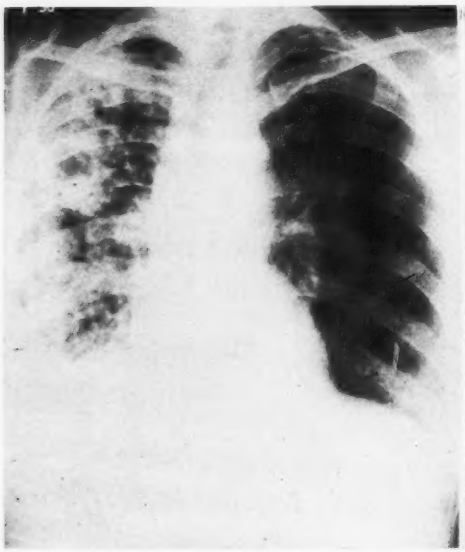

Fig. 1. Unilateral lesion. The productive type predominates.

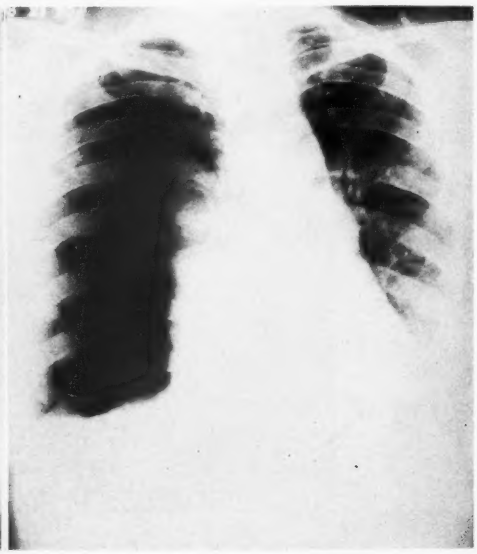

Fig. 2. Pneumothorax is well established. The cavities are closed.

Those of us who have been concerned with this type of work for a period of considerable length, will easily recall how patients used to be kept in bed more or less, year in and year out, without a great deal of hope for a final cure. They often became disgusted with the chronicity of their hospitalization and not infrequently departed in the dark of the night or by the open window, to shift for themselves on the outside. Such departures at the present time are rare and usually indicate a disordered mentality rather than a disgust with the treatment given. There is a great deal of comfort in the new hope

[1] Presented as a clinic before the Radiological Society of North America at the Twentieth Annual Meeting, at Memphis, Tenn., Dec. 3–7, 1934.

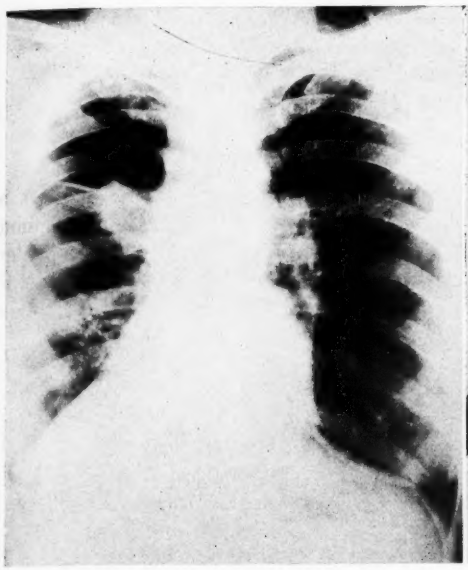

Fig. 3. After four years of pneumothorax the lung is gradually re-expanding.

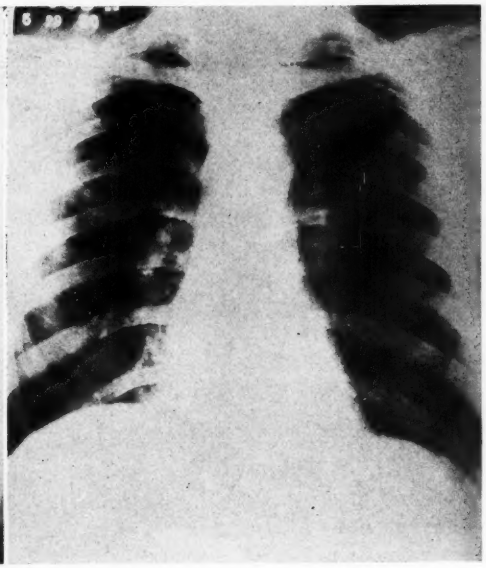

Fig. 4. Central cavity, right side.

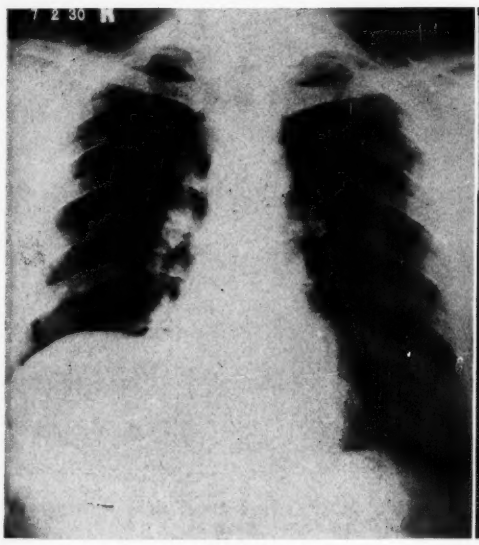

Fig. 5. Same case one month later. Cavity completely closed by phrenic paralysis.

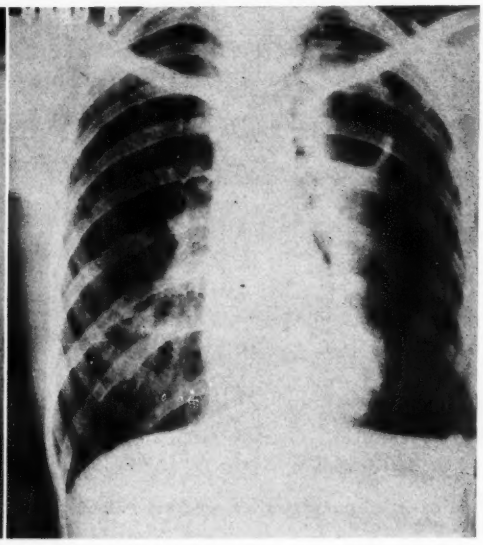

Fig. 6. Pneumothorax failed to close large cavity.

given the patient, through the results of surgical procedures. This enthusiasm has reached the patients and good results have been reported to them, and they not infrequently request surgical intervention for themselves.

We thought it might be of some interest to find out if any definite conclusions could be arrived at from the study of a number of cases treated within the past four years. We selected, therefore, the productive type of lesion, or those types most difficult

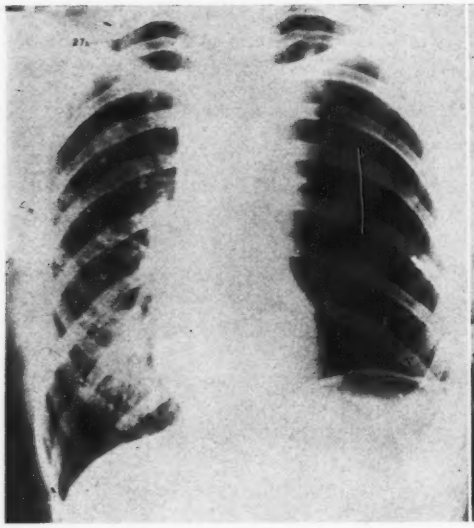

Fig. 7. - By adding phrenic paralysis, cavity closed.

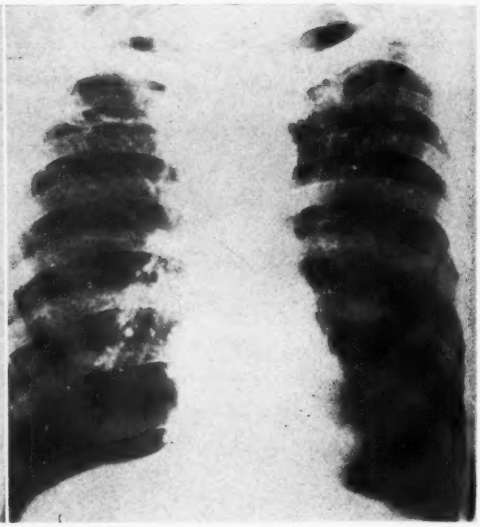

Fig. 8. Bilateral large excavations.

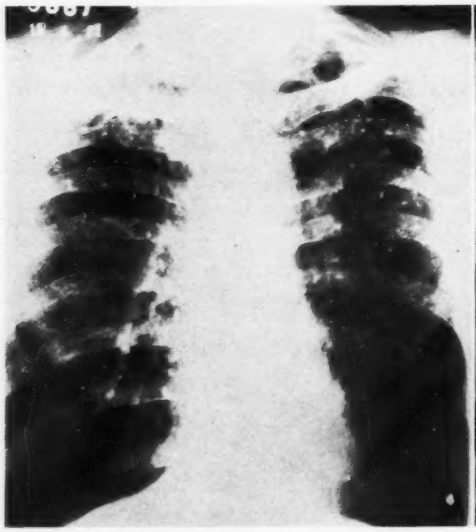

Fig. 9. Same case after one year of bed rest; cavities almost closed.

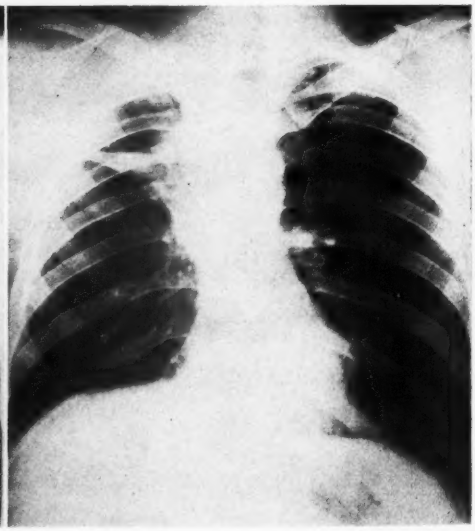

Fig. 10. Large cavity, upper right. Phrenicectomy reduced its size.

to treat because of their tendency to chronicity. The entrance x-ray examinations at Herman Kiefer Hospital were reviewed from 1930–1934 and the first 500 cases of productive lesions encountered were selected, regardless of the extent of disease, because we thought their study would furnish a fair cross-section picture of the fate of the chronic cases. These cases were followed through their entire stay in this hospital and their condition upon departure was tabulated. A follow-up beyond this point has not yet been possible, but it will be reported later.

Of all patients admitted in this four-year period, 23.2 per cent showed the

productive type of lesion, that is, they were either entirely productive or this type of lesion predominated. All the others admitted were more acute, that is, had either exudative or mixed lesions, in the group in which the exudative type predominated. This does not mean that our present hospital population maintains this same percentage, because we see very often that the exudative lesion changes to the productive type of lesion during the patient's stay in the hospital.

The productive lesion is usually of the neglected type. The patients often give histories of chronic cough and expectoration, so that some other condition has been suspected until an x-ray examination tells the tale. Others have known of their exposures and have neglected to seek treatment until such time as they have become quite completely incapacitated. This latter group offers us little choice in the treatment to be given.

In a few of these extreme cases, some form of collapse therapy was attempted, and they are listed with the others in summing up the results of any form of therapy, thus reducing the percentage of good results. In this series of cases, very nearly every death can be accounted for by neglect in treatment—and we mean neglect by the patient himself.

We divided all cases into three groups, according to the outline given by the National Tuberculosis Association, namely, minimal, moderately advanced, and far advanced.

TABLE I.—MINIMAL UNILATERAL (67 CASES)

TREATMENT AND RESULTS

	Bed Rest	Phrenic Interruption	Artificial Pneumothorax	Phrenic Interruption, Pneumothorax
Total	42	23	1	1
Improved	36	22	1	1
Not improved	6	1		
All sputum tests negative	35	17		
All sputum tests positive	2	1		
Sput. became neg. after treatment	5	5	1	1
Expired (enteritis)	1			
Tuberculosis of pleura	1			
Tuberculosis of kidney		1		

Table I includes the minimal unilateral lesions and the great majority of these cases did not show sufficient disease to warrant other than bed rest treatment. Many of these cases were, to all appearances, well arrested and were kept for observation to permit us to study the lesion and to determine, if possible, any tendency to spread or to retrogress. We feel that no matter how minute a lesion may be, if the diagnosis of tuberculosis can be made from an x-ray examination, hospitalization should follow. During a short period of such hospital stay, the lesion can be studied definitely by serial x-ray examinations and a fairly accurate prediction as to the future of the case can then be made. Some readers will probably think that these records show evidence of over-treatment, but we did not think so as we examined the serial films in each case.

The diagnosis of a minimal lesion was definitely made in these cases, on x-ray evidence, and if this evidence is sufficient for a diagnosis, it should also be sufficient as a basis of therapy when, as often happens, other findings are lacking. This is especially true in the acute exudative processes, but it is also true in the productive type of lesion.

TABLE II.—MINIMAL BILATERAL (31 CASES)

TREATMENT AND RESULTS

	Bed Rest	Phrenic Interruption	Artificial Pneumothorax
Total	21	9	1
Improved	18	9	1
Not improved	3		
All sputum tests negative	18	8	
Sputum became neg. after treatment	3	1	1
Pott's disease	1		
Tuberculosis of pleura	1		
Tuberculosis of ribs	1		

The bilateral lesion becomes a more serious affair; with a fairly equal amount of involvement on the two sides, it is often necessary to use a short period of bed rest, especially when the sputum is negative, before the best type of additional therapy, if any, is decided upon. The main con-

cern is to produce a persistently negative sputum. An interesting observation to be drawn from Tables I and II is this, that in only one case in the unilateral group did the disease progress under hospital régime sufficiently to require the combination of pneumothorax and phrenicectomy, and in only one case in the entire series did the disease pass out of control. From this, one should be able to conclude that the treatment applied to the minimal lesions must have been entirely successful, inasmuch as there was only one death (enteritis), and the other patients were all considered sufficiently well established toward a cure to be dismissed from the hospital.

TABLE III.—MODERATELY ADVANCED UNILATERAL (38 CASES)

TREATMENT AND RESULTS

	Bed Rest	Phrenic Interruption	Artificial Pneumothorax	Phrenic Interruption, Pneumothorax
Total	10	19	4	5
Improved	9	17	4	5
Not improved	1	2		
All sputum tests negative	6	7		
All sputum tests positive	1	5		1
Sputum became neg. after treatment	2	7	4	4
Cavities present before treatment		4	4	2
Cavities closed after treatment		4	4	2
Expired	1			
Enteritis	1			

The number of colored patients in this series is nearly 10 per cent, which is also about the same as our colored population at this hospital at the present time. Their response to treatment is nearly the same as in the white patients and their stay in the hospital is about the same in length of time. If they did not respond as well as the white and required longer periods of hospitalization for a given type of lesion, we would gradually be accumulating a colored population out of proportion to the white, and this is not the case. In the minimal class, they formed 12 per cent of cases; in the moderately advanced 4 per cent, and in the far advanced group 12 per cent. From these figures, we conclude little except that their inferior living conditions will probably best explain any seeming difference between them and their white neighbors. We have been unable to show any definite difference between races in response to any type of treatment.

In the moderately advanced group, we found 142 cases as against 98 in the minimal group, and of these, only 38 (or about one-third) were unilateral. This shows that in two-thirds of the cases with excavation, or in lesions of sufficient extent to be classed in this group, there is a tendency to involve both lungs, and so complicate the treatment.

Bed rest in the unilateral group was used in only one-quarter of the cases and phrenic interruption was sufficient in just one-half

TABLE IV.—MODERATELY ADVANCED BILATERAL (104 CASES)

TREATMENT AND RESULTS

	Bed Rest	Phrenic Interruption	Artificial Pneumothorax	Phrenic Interruption, Pneumothorax	Thoracoplasty
Total	48	27	16	12	1
Improved	30	23	12	11	1
Not improved	18	4	4	1	
All sput. tests neg.	32	10			
All sput. tests pos.	11	7	8	2	
Sput. became neg. after treatment	5	10	8	10	1
Cavities present before treatment	4	8	3	3	1
Cavities closed after treatment		7	3	3	1
Expired	5				
Enteritis	2	1			
Laryngitis	2				
Meningitis	2				
Tuberculosis of kidney	2		1		
Peritonitis	1				
Epididymitis	2				

to bring the lesions under control. Only one-eighth of these cases required as much collapse as a combined phrenic interruption and pneumothorax. Some of these cases had negative sputum and yet there were cavities visible in the x-ray film. These cases were treated just as vigorously as were those with positive sputa, because we have observed that open cavities may yield negative sputum for periods of several months before a positive sputum appears. Much valuable time had then been lost and treatment had become very difficult.

In the bilateral class of this group, we find an increase in the number of cases in which bed rest alone was the most suitable treatment. Extrapulmonary complications or poor physical condition was the cause of such a decision; or a purely fibrotic lesion, showing little if any signs of activity and no excavations, would also be treated in this manner. The usual policy is to find out, first of all, if the side having the largest cavity or the worst lesion will allow successful pneumothorax, and as soon as that has been determined, immediately give a phrenic crushing to the opposite side. In all cases, an attempt is made to close any and all cavities in the shortest possible time and render the sputum persistently negative. If we have bilateral excavations and bilateral pneumothorax can be used, a phrenic crushing is often added to the side which is slowest in its response to pneumothorax, again attempting to close any gap which may yield positive sputum.

The relatively short time in which a phrenic paralysis may completely close a cavity is so outstanding that there is a temptation, very well founded on experience, to do a phrenic crushing first, in a unilateral lesion, just to see what it may accomplish, and later add additional therapy as needed.

The far advanced group comprises more than half of the entire number, and, even in the unilateral group, eight were unable

TABLE V.—FAR ADVANCED, UNILATERAL (35 CASES)

TREATMENT AND RESULTS

	Bed Rest	Phrenic Interruption	Artificial Pneumothorax	Phrenic Interruption, Pneumothorax	Thoracoplasty
Total	8	7	6	8	6
Improved	1	4	4	8	4
Not improved	7	3	2		2
All sputum tests positive	8	3	2		2
Sputum became neg. after treatment		4	4	8	4
Cavities present before treatment	5	5	4	8	4
Cavities closed after treatment		4	3	8	4
Expired	3				2
Empyema			1		

TABLE VI.—FAR ADVANCED, BILATERAL (225 CASES)

TREATMENT AND RESULTS

	Bed Rest	Phrenic Interruption	Artificial Pneumothorax	Phrenic Interruption, Pneumothorax	Thoracoplasty	Bilateral Pneumothorax
Total	123	21	33	31	10	7
Improved	19	14	18	21	9	2
Not improved	104	7	15	10	1	5
All sputum tests negative	9	3				
All sputum tests positive	106	11	19	16		5
Sputum became neg. after treatment	8	7	14	15	9	2
Cavities present before treatment	69	11	26	17	10	5
Cavities closed after treatment	5	7	15	16	10	
Expired	61	1	8	5	1	1
Laryngitis	5	1				
Genito-urinary tuberculosis		1				
Enteritis	7			1		1
Pott's disease	2					
Meningitis	1					

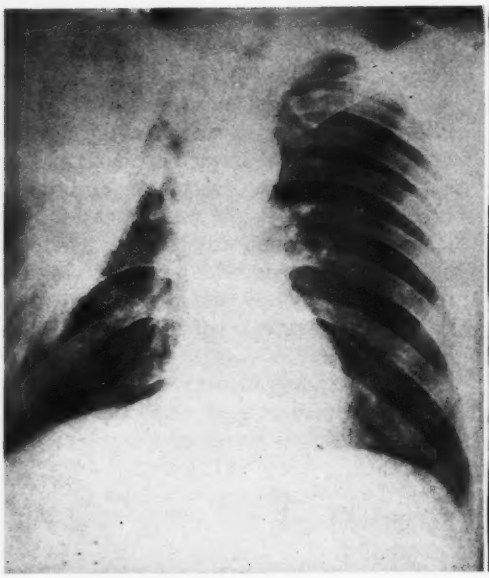

Fig. 11. Following thoracoplasty, the cavity closed and the sputum has been negative since.

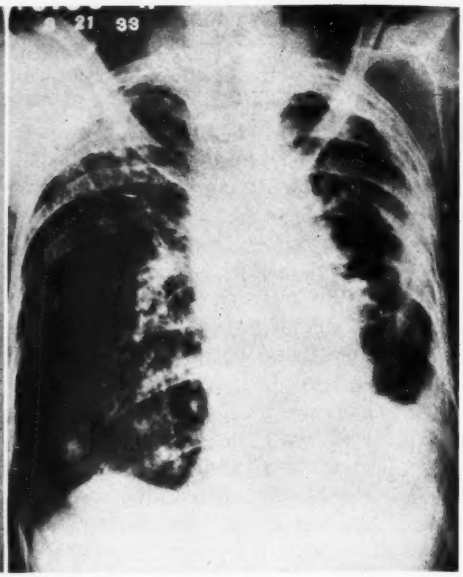

Fig. 12. Bilateral disease. One lung almost completely excavated. The patient was too ill for active therapy. Died about two months later.

to receive anything but bed rest and symptomatic therapy. In the bilateral group, one-half of all cases were unfit for any other therapy. Here we find the best example of the really and truly neglected and hopeless cases. These patients also have the greatest number of extra-pulmonary complications, such as enteritis and laryngitis. Heroic treatment is often necessary and every attempt is made to close cavities. Often the patient's age makes any surgical procedure hazardous, and prolonged bed rest with symptomatic treatment offers the only way out. The column of "died from tuberculosis" is filled from this group.

It may be said in general that few occupations predispose in any way to pulmonary tuberculosis, but we find that food handlers develop a rather high incidence of the disease. We have found bakers and table waiters with far advanced disease, and, with many persons in such occupations having far advanced pulmonary lesions, it is easy to understand why it is that many other patients are unaware of the source of their infection. One is safe in assuming that many a dish served by such a person contains more than an average toleration dose of tubercle bacilli. The most common complications are enteritis and laryngitis, but as soon as the pulmonary pathology is under control and cavities are closed, these extra-pulmonary complications usually subside. Neither bone nor genito-urinary tuberculosis is common in cases with pulmonary tuberculosis. Quite a few of these patients had diabetes but it interfered very little with any treatment and they responded to therapy about as well as those who do not have diabetes.

The number of thoracoplasty cases in this series is very small, which fact does not in any way mean that few needed it, but that many of those who might have come to that stage were too ill or too old to tolerate surgery. The oldest person in this series was 83 and the youngest 13 years. The average age for all groups here listed is 32.8 years.

An interesting observation in this series is that there were nearly twice as many males as females, and this was true both

in the white and the colored. We believe that inasmuch as this type of lesion is the neglected one, this proportion indicates simply that the male in all races is more likely to disregard the early signs of illness produced by tuberculosis and pass through the more acute stages of the disease before seeking medical aid.

These patients were discharged from the hospital only when the disease was under control and no more surgery was indicated. Some of them had positive sputum when they were transferred and these include the class that was too old to receive any active treatment and will probably spend the remainder of their lives in hospitals. A few left to be deported and some went home against advice. Patients doing well with pneumothorax and phrenic paralysis were discharged to convalescent homes and hospitals to continue rest and an inactive type of treatment.

The average hospital stay in this group was three and one-half months. This does not mean that the disease can be cured in so short a period of time, and several factors must be borne in mind. Many in this series died very shortly after entering the hospital. Some were too old to receive much active treatment and were transferred to places where they could spend the rest of their days in fair comfort. The minimal cases and those considered to be arrested were also often discharged to convalescent homes in the above mentioned short period of time. Those from Groups 2 and 3 who were in condition to receive active therapy were our guests for much longer periods, the time indicated above being simply an average for all types of cases.

We have selected roentgenograms to illustrate the various types of treatment used and the results (Figs. 1–12).

CONCLUSIONS

1. The chronic case in tuberculosis will respond as well as any type to active collapse therapy.
2. Statistical results of death from tuberculosis are made up mainly from the type of case entered at the hospital in such an advanced stage that nothing can help.
3. The colored race have the productive type of tuberculosis in about the same ratio as the white, and respond to any treatment as well as other races.
4. The productive lesion occurs in males nearly twice as often as in females.
5. There were very few discouraging results or accidents in any group in which active collapse therapy was considered applicable.
6. Few complications actually contraindicate active therapy.
7. Very few cases with positive sputum should be treated with bed rest alone, provided their physical condition allows more active therapy.

THE PROGRESS, INDICATIONS, TECHNIC, AND SUCCESSFUL RESULTS OF RADIOTHERAPY IN PROSTATIC HYPERTROPHY[1]

By I. GONZÁLEZ-MARTÍNEZ, M.D., Roentgenologist, Clinica Diaz-Garcia, *San Juan, Puerto Rico*

A PROBLEM of so much interest as this cannot be approached scientifically without determining beforehand the true anatomic concept of the disease, since the therapeutic action of the radiations has to be controlled by the variable radiosensitivity of the various tissues which form the prostate.

The investigations carried out during the last thirty years have given rise to the paradoxical doctrine that in the so-called hypertrophy of the prostate the gland itself is not hypertrophied but, on the contrary, as Motz and Perearnau (1) demonstrated in 1905, the histologic examinations revealed in the majority of the cases the existence of an inverse anatomic process, which is the atrophy of the glandular tissue. This point of view, later supported by Marquis in 1910, Cunéo in 1911 (2), Tandler and Zuckerkandl in 1911 (3), and Marion in 1912 (4), received absolute confirmation in the brilliant work of Papin and Verliac (5), directed toward the proof that, with a careful histologic study of a great number of specimens, the so-called hypertrophy of the prostate is not a genuine disease of the prostate but of the posterior urethra, since it does not originate in the prostate itself but in the hyperplasia of the peri-urethral glands, especially those of the posterior aspect of the urethra. The disorderly proliferation and the increase in size of these glands cause the true prostatic tissue to be pushed toward the periphery against the capsule, and it suffers to a greater or lesser degree in consequence of a mechanical atrophic compression.

Thus the peri-urethral extra-prostatic tumors are formed, more or less increased in size and of a varied histologic structure, according to the anatomic element upon which the vicious tendency to abnormal multiplication falls. That is to say, in the peri-urethral gland we have, beside the true glandular tissue, formations of supportive connective tissue and muscular fibers. If the hyperplasia is developed by preference in the glandular tissue, then pure adenomas will form, which clinically present themselves as tumors of soft consistency prone to increase to a considerable size. If not only the glandular tissue but also the connective stroma participates markedly in the neoplastic development, then the result is a fibro-adenoma, which also shows a tendency to become a voluminous tumor of soft consistency, though not so much so as the one previously mentioned. When the glandular tissue is not involved or is involved to a slight degree only, allowing the connective tissue the predominance in the hypertrophic tendency, then the glandular acini are choked and there is a pure fibroma, which is clinically recognized on palpation by its woody consistency and small volume. Accordingly, whether or not the hypertrophy affects the connective tissue or only the muscular elements, we will have as a result fibromyomas, adenomyomas, or true myomas.

The classification of these anatomic varieties have great importance from the therapeutic point of view, because upon the correct diagnosis of each clinical type and the complications from each will depend the final decision as to the most logical treatment in each case.

The so-called prostatic hypertrophy is a disease very common after the age of 50; it may be stated that more than 40 per cent of persons over this age are bound to suffer from this disease, and among these 14 per cent, according to Albarran and 20 per cent according to Pauchet (6), will die as victims of a cancerous degeneration.

[1] Read by title before the American Congress of Radiology, in Chicago, Sept. 25–30, 1933.

From the clinical point of view we may consider two morbid types, corresponding to two distinct stages in the course of the disease, *i.e.*, the soft or congestive hypertrophy and the hard or fibrous type.

The congestive type occurs at the beginning of the disease and also in some chronic cases of long standing; anatomically, it is characterized by the predominance of adenomatous formations in active development, and clinically it is expressed by the so-called premonitory functional disorders. The hard type is a fibroadenomatous growth of late organization, generally found in a more advanced period of the disease. To the glandular hyperplasia is then added that of the connective and muscular elements; when this proliferation of the stroma chokes and eliminates the glandular acini we get the sclerotic prostate. The clinical manifestations in the stage of full development of the disease include the symptoms generally attributed to prostatic hypertrophy with or without vesical residue.

The prostatism without prostate (*prostatisme sans prostate*) is clinically the manifestation of localized hypertrophies, which at times is to be found in the group of subcervical glands, again in the prespermatic glands, and also in adenomas of intra-urethral development. The name is so given because, in spite of the fact that prostatism without prostate is apt to produce all the signs of hypertrophy and even the complete urinary retention, rectal examination does not show the least change in size or consistency of the prostate. The cystoscopic or posterior urethroscopic examination will plainly show the true extraprostatic pathologic condition.

To-day, science has at the specialist's disposal neat methods of investigation to facilitate an exact diagnosis. The family history, clinical history, physical examinations, the exploring catheter, cystoscope, and even the endoscope, assisted chiefly by rectal examination, will disclose not only the glandular hypertrophy from its outset but also the anatomic varieties, longitudinal modifications, deformations, and change of direction of the deep urethra. But above all it will give exact information concerning the consistency of the hypertrophy, which is the master key to therapeusis.

If by chance the patient happens to appeal to an x-ray specialist shortly after the appearance of the premonitory disturbances, which consist of frequent nocturnal mixturition, more or less marked dysuria, loss of strength, and early morning delay in initiating the flow of urine, then he will have arrived at the ideal moment for an efficient course of treatment, not only because, as we have stated before, the prostatic adenoma is in the process of evolution, but because the general health of the patient has not yet been disturbed. Unfortunately, however, we radiologists rarely see prostatic patients at this stage of the disease.

If by chance the patient should come for consultation in the fully developed stage of the disease, when disturbed by alarming symptoms, the exploring catheter reveals the presence of vesical residue coinciding with an enlarged and soft prostate, then x-ray therapy can give legitimate hope of an effective cure. The same result is also possible when the patient comes, assaulted by frequent attacks of acute retention, complete or incomplete, but without distention. However, if the patient should come for consultation, a victim of chronic retention with vesical distention, no matter what the volume and consistency of the prostate, or when the physical examination reveals the syndrome of prostatism without prostate or reveals the existence of a small sclerotic prostate, then radiotherapy is ineffective and ought to give place to surgery.

Since the time of Freyer (7 and 8), who popularized the Fuller (9) operation, in 1901, the advantages and superior technic of transvesical prostatectomy were demonstrated: this process remains in genitourinary surgery as the ideal treatment for prostatic hypertrophy. However, its efficiency is not absolute because, even in ex-

pert hands, there is a mortality risk of more than 3 per cent.

On the other hand, many patients with congestive prostates, whether or not complicated with vesical residue, but suffering from the entire group of premonitory symptoms, do not complain of attacks of retention because the habits of a peaceful and moderate life keep them out of the acute stage. In such cases, there being no real obstacle to the emission of urine, there is no reasonable cause for advising prostatectomy.

Likewise, when the presence of acute renal complications, serious troubles, or high azotemia definitely endanger the results of the surgical treatment in the classic prostatism, whether complicated or not by chronic retention with vesical distention, it is necessary for the surgeon to adopt the use of palliative methods, more conservative although less efficient. From the above and the irrefutable proofs produced long ago by radiophysiology concerning specific radiosensitivity of the adenomatous tumors, it is deduced that radiologic treatment of prostatic hypertrophy will be indicated with promise of brilliant results in cases in which surgery is not justified or where contra-indications to prostatectomy are demonstrated.

But it should be borne in mind, also, that even in cases of clearly justifiable surgery of the prostate, radiotherapy is apt to offer the same probabilities of clinical cure without anesthetic risk, post-operative complications, or confinement to bed, as long as the prostate is soft and congested.

In summary, radiotherapy is indicated:

1. In cases of incipient prostatic hypertrophy, when only premonitory symptoms appear.

2. In all cases of soft and congestive hypertrophy (in its residual stage), with or without acute retention accidents.

3. In cases of chronic retention without distention, when these occur with voluminous adenomas or fibro-adenomas.

4. As palliative treatment of chronic retention with distention, in patients with marked azotemia or with serious anatomic or functional disturbances of the heart or kidneys.

5. On the other hand, radiotherapy should be withheld in cases of sclerotic hypertrophies, in prostatism without prostate, and in malignant degeneration of adenoma, when the neoplastic production has surpassed the limits of the *Denonvillier's fascia*.

More than thirty years ago the suspicion of a possible regressive action of x-ray therapy on glandular hyperplasias inspired investigators to perform a therapeutic test on benign neoplasms of the prostate. To an American, Heber Robarts (10), is due the glory of being the first to report, in 1902, three cases of congestive hypertrophy greatly improved by irradiating the gland through the perineum. At that time radiotherapy was still in its infancy. Since then its progress has been enormous, not only stimulated by the appearance of more potent and more perfect x-ray generators every year, but also determined by the discovery of the fundamental laws of radio-physics (11) and radiobiology (12); important acquisitions which favored the employment of high voltages and thick filters, indispensable for the administration of adequate doses of radiant energy in the depths of the prostatic fossa.

Robarts' attempt was not overlooked, for, three years later, Carabelli and Luraschi (13), followed later by Moskowicz and Stegmann (16), published in the medical literature of their respective countries, Italy and Austria, and transmitted to the First International Congress of Physiotherapy held in Liege, in 1905 (15 and 16), the successful result of their experiments with radiotherapy. Their results were obtained in prostatic hypertrophy in patients affected with vesical residue and retention of urine, who had a decrease in residue and disappearance of retention under the exclusive effect of the x-rays. The technic of the Italian investigators differed, however, from that of the Austrian, for while the first focussed the prostate through the perineum, Moskowicz and his

followers applied the x-ray through the rectum using a wide speculum. It is evident that this procedure, revived two years later by Schlagintweit (17) and Hoenish (18), would soon be out of use, not only because of discomfort to the patient but also because it would not allow a uniform radiation of the tumor, since no matter what the position of the patient might be, the incidence of the x-ray beam was oblique and tangential to the posterior surface of the prostate. However, Carabelli and Luraschi's technic, following the route outlined by Robarts, by choosing the perineal region, opened the way to a reasonable and promising route for attacking the prostatic adenoma with greater efficiency. The method consisted in applying at a skin-anode distance of from 20 to 25 centimeters one-third to one-half of an erythema dose two or three times a week, at first, and every 15 days later, up to a total of 15 applications, using rays of a hardness of 6 or 7 Benoist. That this procedure was worthy of imitation was later demonstrated by the experiments of Tansard and Fleig (19), of Hunter (20), and of others.

While these investigators operated by irradiating the prostate directly, Wilms and Postner, in 1911 (21), and O. Ehrmann, encouraged by the regressive effect which the irradiation of the ovaries produced on uterine fibromas, thought it logical to expect, from separate irradiation of the testicles, a similar result on the prostate, and, therefore, preached this procedure of indirect radiotherapy which was strongly and justly criticized by Zindle as inefficient and unnecessary.

Since 1906, the experiments of Freund and Sachs (22) on prostates of dogs had proved that strong x-ray doses, even of the slight penetration available at that time, determined the sclerosis of the gland and in consequence reduced its volume. However, it was not until 1913 that the interesting paper read by Haret (23) before the Congress of Medicine in London, presented a practical method which showed evident progress over previous experiments.

Shortly afterward Tousey (24), in 1915, reported his partial success from irradiating the prostate every two days through the perineal region with rays of 7 Benoist filtered through sole leather, up to an erythema dose or 5 H. units.

In 1920, Albert Weil described in his Treatise of Radiology (25) a perfected and more efficient technic than the former ones, with the application of rays of more potent penetrability (120 K.V.) filtered through 10 millimeters of aluminum and directed at the prostate in cross-fire from two portals of entry, one anterior, supra-pubic, and the other posterior, perineal. The testicles were not protected and, in order to reach in depth a greater dose through the perineal field, the patient was laid on his abdomen, the buttocks being raised with a cushion. Through each of these fields Weil administered from 10 to 12 H. with 20 centimeters anode-skin distance. These applications were repeated monthly for four or five months.

Two years later Nogier (26 and 27), in order to improve and modify his technic for attacking the tumor only through the perineal region, had a special chair known in France as *Nogier's horse*, on which the patient sat astride to receive the treatment from a tube placed underneath. He employed weaker rays (100 K.V.) than did Weil, with less efficient filtration, since this did not exceed 4 millimeters aluminum. Nevertheless, Nogier assures us that in the prostatic congestion at the beginning of the disease a cure can be effected in four weeks, applying weekly a little over one-third of an erythema dose, and that in glandular hypertrophy improvement usually takes place during the sixth week.

In the following year, 1923, Haret (28) and his pupil Devois (29) changed their initial technic, raising the voltage to 120 K.V. and administering 275 r units, through the perineum each week for ten consecutive weeks, up to a total of two erythema doses. These doses were higher than those he gave at first and those advised by Nogier and Weil, but the technic was defective in that it employed filters of only 5 millimeters of aluminum, not

thick enough to irradiate efficiently, and without injuring the skin, organs situated at a depth of from 7 to 8 centimeters.

A year later Ledoux-Lebard (30) gave a formidable impulse to radiotherapy of prostatic hypertrophy by abandoning the medium tensions and applying the principles of deep therapy. In order to insure a uniform radiation of the prostatic fossa, he used two portals of entry, one suprapubic and the other perineal, and through each one of these he gave fractional doses during a month, totaling 1,200 international r units at 200 K.V., filtering through a millimeter of copper.

Wetterer (31), although advocating the exclusive radiation through the perineum, also uses very penetrating rays (200 K.V.) and thick filters, administering strong doses (15 H.) at a sitting, but giving treatments every three or four weeks.

Holfelder (32), inspired by Nogier's method, attacks the prostate through the perineum, irradiating it from the bottom up with ultra-penetrating and well filtered rays. For this he uses a cylinder of his own invention, electric shockproof and impermeable to x-rays. This cylinder has an opening where the various cones and filters can be inserted and through which passes the beam of x-rays coming from the anticathode of a tube inside the cylinder. This, moreover, has up-and-down, rotary, and inclined movements, adaptable to every conceivable position. The patient must sit, resting the perineum on the radiation cone, so that the body weight compressing the perineum will reduce the distance from the skin to the prostate to a minimum of 6 centimeters. Thanks to this apparatus, Holfelder obtains a dose sufficient in depth to produce, without the slightest injury to the skin, the regression of the hypertrophied gland. This appliance is very comfortable, but has the disadvantage of being high-priced; therefore, its use is limited to large institutions.

Iser Solomon's (33) technic is similar to that of Haret, utilizing the perineal field through which he gives, in 10 or 12 applications, a total dose of from 2,500 to 3,000 r international units of rays at 200,000 volts, filtered through 0.5 mm. of copper plus 1 mm. of aluminum. He admits that he has obtained good results in soft hypertrophies.

In 1927, Vignal (34 and 35) recommended exclusive radiation through the perineum, placing the patient in a lateral position with the thigh flexed on the abdomen and the leg on the thigh. However, this position does not permit a uniform radiation to the prostatic fossa. He used two methods, one for apparatus with an average penetration of 120 K.V., filtering through 6 mm. of aluminum, and another for deep therapy apparatus using from 150 to 200 K.V. In both cases he gave fractional weekly treatments of 180 to 360 r up to a total of from 2,275 to 2,725 r.

Pierre Lehmann, in 1932 (36 and 37), revived Weil's technic with respect to the selection of the portals of entry and the position of the patient on the table, but he employed tensions of 200 K.V. and filters through 0.8 mm. of copper plus 2 mm. of aluminum, increasing the focus-skin distance to 45 centimeters. He administers a total dose of 1,800 r through the suprapubic field, divided in four doses of 450, and through the perineum 1,400 r, distributed in four doses of 350 r. The treatments are repeated every two days until the completion of the series.

Secondary only to the work of Ledoux-Lebard and his followers, this work of Lehmann represents one of the most valuable contributions to non-surgical treatment of prostatic hypertrophy. However, it should be noticed that, except for his heavier doses, his technic differs very little from that of Ledoux-Lebard.

Ever since 1920, the author has applied radiotherapy to selected cases of prostatic disease. As at that time our equipment did not allow the use of voltage higher than 100 K.V., we had to operate under conditions limited by filtration and distance. The factors we used were as follows: K.V. 100; focus-skin distance, 25 cm.; filter, 4 mm. aluminum; a 10 cm. circular portal of entry for the perineum;

position of patient, gynecologic semi-Trendelenburg; milliampereage 3 to 5 ma. through a standard large focus Coolidge tube; time, 5 minutes; dose 0.5 to 1 H. unit. The treatments were repeated every two days to a total of 10 units H., measured with the Corbett's radiometer. With this procedure, though the result was favorable, especially when we attempted to deal with pre-hypertrophic congestive phenomena, we nevertheless did not obtain cures of long duration except in one of the four cases observed. But, in 1922, we installed a deep therapy equipment of 280 K.V., and we immediately changed to a technic similar to Weil's, but improving the tension, filter, and distance factors, which we substituted, respectively, for 150 K.V., 0.5 mm. of copper plus 1 mm. of aluminum in addition to 1 mm. of celluloid and 50 cm. skin-anticathode distance. In 1924, we adopted the Ledoux-Lebard method as regards kilovoltage, filtration, and dosage, but still kept Weil's position for the patient.

From that time up to date our technic has changed little, the constant factors being as follows: voltage, 180 to 200 K.V.; filter, 1 mm. copper plus 1 mm. aluminum; distance, 50 cm.; tube, high voltage Coolidge water-cooled and 25 milliamperes per minute. According to Lehmann and Albert Weil's method, we irradiate through two fields, one suprapubic and the other perineal, but rectangular, and of 12 × 15 cm., administering through each a total dose of 1,500 r, divided in five fractional treatments of 300 r. At each sitting we irradiate only one field and repeat the treatment every two days, alternating the suprapubic with the perineal field. In this way, 18 days are required for a complete series. As the prostate lies from 8 to 10 cm. from the pubic and some 7 to 8 cm. from the perineum, it will absorb more than half of the 3,000 r administered to the skin, a deep dose sufficiently active even in case of incipient malignant degeneration.

It is very important to be sure beforehand of the true location of the prostatic urethra, datum best obtained by rectal palpation with the patient lying on the treatment table in the same position in which x-rays are to be applied, since only in this manner is it possible to find the most convenient direction of the x-ray beam and, with approximate exactness, the distance from the organ to the skin of the pubis and the perineum. We employ a seasoned wooden localizer covered inside by a thick lead shield, with an opening of 12 × 15 cm.; for the irradiation of the suprapubic field this localizer, if possible, must be held pressed firmly against the abdominal wall until its inferior edge comes in contact with the pubis. To irradiate the perineal field we place the patient, as does Weil, on his abdomen with the thighs well separated, raising the buttocks as high as possible by means of cushions, until the perineum can be well seen and then, with the same localizer, we direct the x-ray beam toward the tip of the coccyx in a straight line to the symphisis pubis.

The undesirable accidents with this method generally occur only with exaggerated doses or when the interval between two sittings is not in accordance with the variable susceptibility of the individuals or with the stage of the disease. They consist of a more or less intense exacerbation of the pollakiuria and the dysuria, as well as of signs of rectal irritation, such as frequent desire to move the bowels with painful tenesmus and whitish or mucosanguineous evacuations. But these inconveniences may be avoided or corrected by lowering the dosage at each sitting or extending to more than two days the interval between them. As a last resort, the treatment should be stopped for a short while.

When everything goes well, the first symptom to improve is the frequent nocturnal micturition, which from the first treatment decreases to the normal. Then comes the improvement of the dysuria and an increase in the strength and caliber of the flow, followed by the disappearance of the morning delay in initiating micturition. In those cases of retention with

scant residue, this may even disappear, but if it exceeds the amount of 200 c.c. we can only expect a decrease. The size of the prostrate is that which takes longest to modify, depending on the nature of the hyperplasias for the rapidity of its regression. When this is purely glandular, it decreases rapidly, but if the connective tissue is predominant, then regression will be late or *nil*. It should be noted, however, that a positive and marked improvement, with disappearance of the urinary disturbances, heavy sensation in the perineum, and decrease in size of the prostatic adenoma, cannot be expected before three months after the completion of treatment. If after this lapse of time, the improvement, though marked, does not continue, it would be advisable to repeat the series under the same conditions. However, if on the contrary, the symptoms are not modified, then it is time to give place to surgery.

Beside the contra-indications enumerated, roentgen therapy should not be advised when there exists severe infection of the hypertrophied gland, although Wetterer recommends it as the ideal treatment for gonococcal prostatitis. Irradiation should not be employed for prostatic adenomas complicated with vesical calculi, urethral strictures, or intraprostatic calculi. On the other hand, in hypertrophies complicated with hematuria due to prostatico-vesical congestion, radiotherapy constitutes one of the best treatments.

The author has treated only twelve cases, which may be grouped thus: four with roentgen therapy of medium voltage (100 K.V.) and filtration through 4 mm. of aluminum; three with semi-penetrating rays (150 K.V.) and filtration of 0.5 mm. of copper, and five with deep therapy, according to the above technic. From the first group only one patient, 55 years old, in the first stage of his disease, complaining only of premonitory symptoms without vesical residue and in whom a rectal examination had disclosed a soft prostate of double the normal size, had a permanent disappearance of the urinary disturbances. To-day, 12 years afterward, he seems to be in good health. From the second group, one patient with incomplete retention and vesical residue of over 400 c.c. had no improvement and it was necessary to recommend a prostatectomy, which was performed by a Baltimore specialist. The other two were of the soft, voluminous type of hypertrophy, without retention or residue; both improved notably and their urinary disturbances disappeared completely. Among the third group there was a man, 80 years of age, who had a vesical residue of over 300 c.c. and a large infected prostate. This patient was treated only palliatively since he refused surgical intervention. He had a disappearance of hematuria, a decrease in the residue to 150 c.c., and an improvement in the pollakiuria and dysuria. His urine, however, remained cloudy and his prostate about the same size, up to the time of his death, which was due to an intercurrent illness. The other four, all cases of soft glandular hypertrophy without attacks of retention, have not been annoyed further by the common symptoms of prostatism.

These results, which are only a confirmation of those obtained with deep therapy by other specialists of Europe and America, authorize us to sustain that, in view of the recent progress in roentgen therapy, it represents the ideal treatment for the so-called hypertrophy of the prostate in its first stage, and that it is, besides, an excellent treatment in the more advanced stages, provided that they are not of the sclerotic type, and that no serious complications exist.

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Box 753

X-RAY EXPERIMENTAL STUDIES SHOWING THAT RACHITIC RATS WITH HEALED BONE LESIONS CONTINUE TO SHOW ALTERATION IN THEIR GASTRO-INTESTINAL TRACT[1]

By L. J. MENVILLE, M.D., J. N. ANÉ, M.D., *and* S. N. BLACKBERG, PH.D., *New Orleans*

Department of Medicine, Tulane University, and Department of Pharmacology, Columbia University

IN ORDER that experimental observations upon animals may have a practical application to man, it is necessary to utilize animals whose diet is very much of the same nature as that of the human species, and whose gastro-intestinal tracts bear a close resemblance to those of primates. In the rat, we have an animal that will ideally serve this purpose, better, in fact, than herbivorous or graminivorous mammals, and the results obtained in young rats should be comparable with those of infants and young children.

In a previous experimental study (1) on the motility of the gastro-intestinal tract of rachitic rats, we reported that in every instance they showed a marked hypomotility when compared with normal rats. As a result of our experiments with rats, it was concluded that the constipation so frequently observed in rachitic children was perhaps the outcome of an altered motility of their gastro-intestinal tracts.

Authorities on pediatrics recognize constipation as a frequent early symptom of rickets and is said by them to become more marked in the later stages of the disease. This symptom of rickets is perhaps the result of muscular weakness and relaxation of the gastro-intestinal tract, and if these changes are not corrected early, it is possible that they will continue long after the patient is considered to be cured of rickets. This is especially important because it is generally believed that infants and children are considered to be cured of rickets when their bone lesions have been proven definitely healed as shown with the x-ray.

In order to ascertain whether or not the healing of rachitic bone lesions in rats would be the cause of relieving them of their constipation, we undertook an experimental investigation in the early part of 1931. The results of this study made on three rachitic rats, with their bone lesions healed by means of viosterol, showed that the hypomotility of their gastro-intestinal tracts remained unaffected. We presented our observations to the Southern Branch of the Society for Experimental Biology and Medicine, in June, 1931 (2).

Realizing that three rats were too small a number from which to draw any definite conclusions as to the results obtained in these experiments, we undertook another similar experimental study, using a larger number of rats and employing several methods of healing the rachitic bone changes, continuing our fluoroscopic observations over a period of months.

In the experiments herein reported, 27 young normal rats were used, each being marked so that correct identification would be possible even months after they had been branded. All of the rats were made to fast for 48 hours, water being withheld during the last 24 hours of fasting. Placed in separate cages they were then fed a carefully weighed meal which consisted of three parts of buttermilk and one part of barium sulphate (making a 10-gram mixture): they were allowed to eat for 20 minutes. The amount of food that was left by each rat was then carefully weighed. In this manner, we were able to keep an accurate record of the amount of food eaten by each one. They were then placed in individual loose cotton bags, as previously described (3), and fluoroscoped to ascertain whether or not their stomachs were filled. Fluoroscopic observations

[1] Read before the Radiological Society of North America, Dec. 3, 1931.

were then made every 15 minutes, until the food column had reached the cecum, and continued until the stomach and small intestine had emptied. The colon observations were made at longer intervals of time because of the slow emptying of this organ. Careful records were made of all our observations, which demonstrated the normal motility of the gastro-intestinal tract of these 27 normal rats. They were then divided into four separate groups and roentgenographic examinations were made of representative rats of each group. In the first group, six of the 27 normal rats previously examined were used. They were fed a deficient vitamin D diet until all showed definite rachitic bone changes as revealed by the x-ray; their gastro-intestinal tracts were studied by means of the fluoroscope. All showed a marked hypomotility. These six rats were then given a normal diet until their bone changes were healed, after which time they were again fluoroscoped to ascertain whether or not the hypomotility previously found was in any way altered. These rats were continued on a normal diet for several months and again fluoroscoped as in the previous examinations. The hypomotility

GROUP 1.—NORMAL RATS MADE RACHITIC: THEIR BONE CHANGES HEALED WITH A NORMAL DIET

Date	Wt.	Ate	Cecum App. time emt.	St.	Sm. in. emt.	Col.	No. rats	Kind
5/10/31	95:6	6:4	2:40	7:10	9:28	69	6	Normal
6/14/31	104:3	7:3	2:08	8:27	10:24	79	6	Rachitic
7/3/31	107:0	7:6	3:01	10:13	12:06	87:8	6	Healed
10/18/31	198:0	9:2	3:33	7:27	11:36	79:2	5	Healed (3 1/2 mo.)

GROUP 2.—NORMAL RATS MADE RACHITIC: THEIR BONE CHANGES HEALED WITH VIOSTEROL

Date	Wt.	Ate	Cecum App. time emt.	St.	Sm. in. emt.	Col.	No. rats	Kind
5/10/31	89	4:4	2:46	6:32	9:11	63	6	Normal
6/14/31	95:6	7	2:10	8:06	10:16	79	6	Rachitic
7/3/31	86:3	8:6	2:43	9:47	11:45	89	6	Healed (viosterol)
10/18/31	195:0	9:3	3:22	7:45	11:02	80:8	6	Healed (3 1/2 mo.)

GROUP 3.—NORMAL RATS MADE RACHITIC: THEIR BONE LESIONS HEALED BY ULTRA-VIOLET RAY

Date	Wt.	Ate	Cecum App. time emt.	St.	Sm. in. emt.	Col.	No. rats	Kind
5/10/31	88:3	6:4	3:07	6:47	9:30	65	6	Normal
6/14/31	102:5	6:8	2:33	8:36	11:07	79	6	Rachitic
7/3/31	136:0	8:8	2:50	9:55	11:31	80	6	Healed (viosterol)
10/18/31	244:8	9:3	2:51	9:20	11:28	81	6	Healed (3 1/2 mo.)

GROUP 4.—NORMAL RATS MADE RACHITIC AND CONTINUED ON A RACHITIC DIET FOR MONTHS

Date	Wt.	Ate	Cecum App. time emt.	St.	Sm. in. emt.	Col.	No. rats	Kind
5/10/31	102:8	7:1	2:42	6:20	9:08	61	9	Normal
6/14/31	121:7	7:2	2:12	8:26	10:32	79	9	Rachitic
10/18/31	144:1	8:4	3:53	9:35	12:13	89	5	(kept on rachitic diet)

found at previous examinations was still evident, and did not return to normal.

In Group 2, six of the remaining 21 normal rats were used and after being made rachitic, as in Group 1, they were fluoroscoped. All the rats of this group showed a marked hypomotility. Their bone lesions were then healed by means of viosterol, and their gastro-intestinal tracts were again fluoroscoped; however, the hypomotility of their gastro-intestinal tracts still persisted. They were then given a normal diet for several months and their gastro-intestinal tracts were re-examined, the hypomotility previously found being still evident.

Group 3, which included six of the remaining 15 normal rats, made rachitic, was examined in the same manner as in Groups 1 and 2. All of them showed a marked hypomotility of their gastro-intestinal tracts. Their bone changes were healed by means of the ultra-violet ray and again fluoroscoped when it was found that the hypomotility previously found remained evident. They were then given a normal diet for several months and again examined, when their hypomotility was found as in the previous examinations.

Group 4 consisted of the remaining nine normal rats which were made rachitic. They were examined and then kept on a rachitic diet for several months, at which time they were re-examined, when their hypomotility previously found was not affected. During the several months of observations their epiphyses united with the shaft, and the characteristic rachitic bone changes were no longer evident. Their hypomotility persisted during this prolonged rachitic diet in spite of the disappearance of their rachitic bone changes.

CONCLUSIONS

These experiments definitely demonstrate that young rats, made rachitic, show a marked hypomotility of their gastro-intestinal tracts, and the healing of their rachitic bone changes by the different means employed do not relieve them of their hypomotility even after a period of months when the bones have healed.

If the life cycle of these rats is compared with that of humans, it must be concluded that if the cause of constipation in rachitic rats is due to muscular weakness and relaxation of their gastro-intestinal tracts, as evidenced by a hypomotility, then rachitic patients, who have had their bone lesions healed by the various methods employed at the present time, are apt to continue to show alterations in the motility of their gastro-intestinal tracts for a long time after they are considered cured of rickets.

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ROENTGEN PELVIMETRY AND FETAL CEPHALOMETRY: A NEW TECHNIC[1]

PRELIMINARY REPORT

By ROBERT P. BALL, M.D., *and* S. S. MARCHBANKS, M.D., *Chattanooga, Tennessee*

IN THE effort to increase the accuracy of obstetrical examination, especially in marginal size cases in which the need for increased accuracy may be vital, we are using the technic described herein. The technics developed and advocated by others, while satisfactory in their own hands, do involve the use of special film markers, the personal equation of the examiner, and rather wide variation in results. Of these methods advocated, we obtained the most information by the use of teleoroentgenograms (S. S. M.). A study of a series of these teleoroentgenograms suggested the value and importance of the visualization of labor, accurate mensuration, the construction of a passenger-passage ratio, and the establishment of a normal fetal increment of increase.

Accordingly we present this simplified technic of pelvimetry and fetal cephalometry. It embodies the use of a circular chart, placed upon the dial of an instrument which corrects for the size of the fetal head and object-film distance. The fetal skull is measured by tracing the instrument around the circumference of the skull on the roentgenogram, and from the chart a corrected circumference measure-

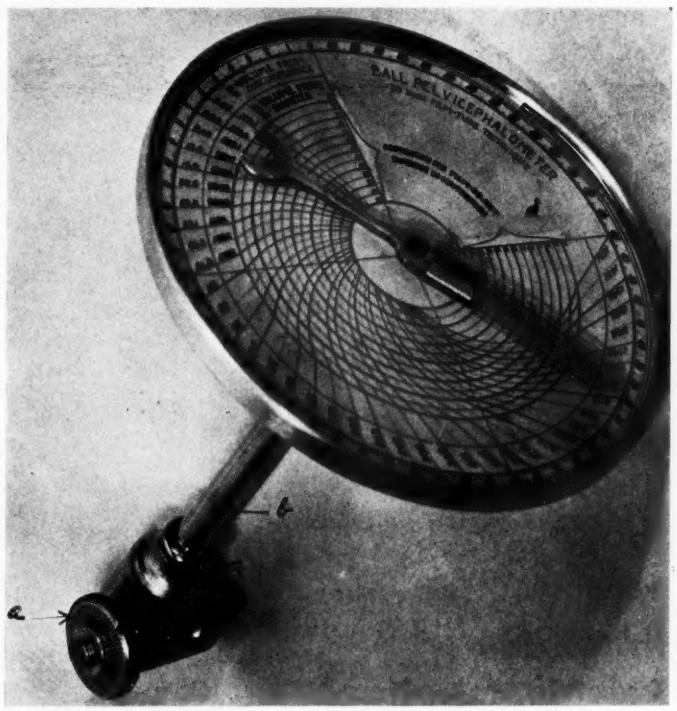

Fig. 1. The pelvicepholometer.

[1] Presented before the Radiological Society of North America, at the Twentieth Annual Meeting, in Memphis, Tenn., Dec. 3–7, 1934.

ment in centimeters is read directly. This is translated into terms of volume in milliliters. The pelvic measurements determined are the anteroposterior diameter (true conjugate) and the ischial interspinous diameter in centimeters, and are translated into terms of volume capacity of a sphere of this diameter. A description of the chart and technic employed, with results, is presented.

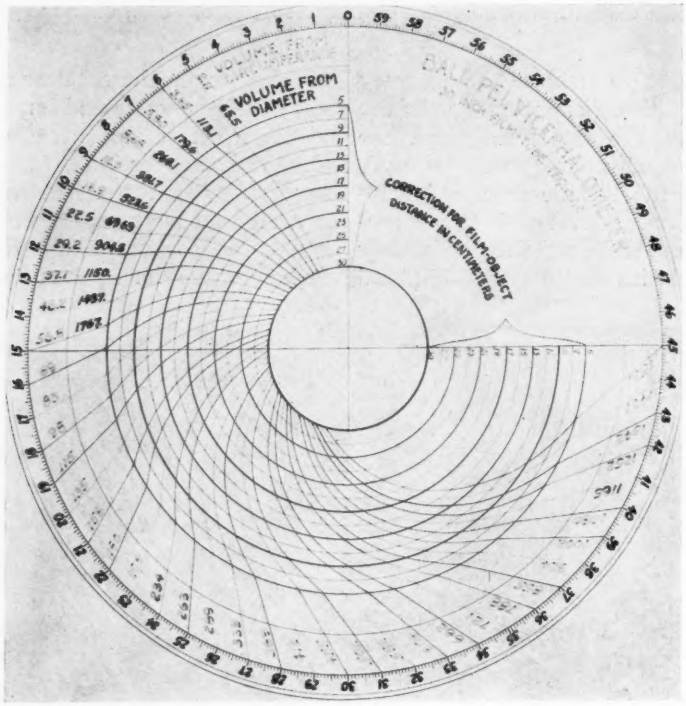

Fig. 2. A chart used as a dial on the instrument to correct the size of the object and film-object distance.

For practical purposes, the fetal head and maternal pelvis must be measurable in relative terms. In the past, it has been customary to compare the diameters of the fetal head with the diameters of the pelvis of the mother. By this means the size of the fetal head was compared with diameter measurements of the pelvis.

However, it has been found that the mean circumference of the fetal head is always obtainable from the anteroposterior and lateral views and is a more dependable measure of the size of the fetus than are diameters. The percentage of error in the reading is reduced in more ways than one. To begin with, it makes no difference how obliquely the head is presented and hereby a larger percentage of films is readable. The units of measure are increased by more than three times the diameter units. In estimating the body weight of a fetus, the mean circumference has been reliable to within one-half pound in over 85 per cent of the cases and to within one pound in the remaining 15 per cent.

The following technic, chart, instrument, etc., were conceived and designed by one of us (R. P. B.) and will be presented as they are used in an examination.

TECHNIC OF EXPOSURE

A film of the pelvis and lower abdomen in anteroposterior view is taken with the

patient in the supine position. The patient is placed in the center of the table over a Potter-Bucky diaphragm and the breech presentation it may be necessary to center the tube and film higher for additional films.

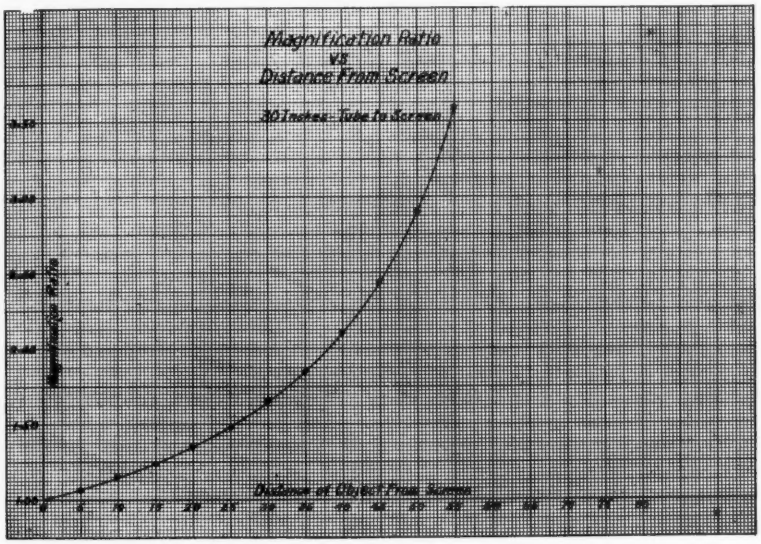

Fig. 3. A chart showing the magnification ratio of linear measurements of objects at varying distances from the film. The target-film distance was 30 inches or 76.2 centimeters. Figures on ordinate represent factor of magnification.

tube is centered over a point midway between the antero-inferior iliac spines. Only a right or left marker is used. A tube-film distance of 30 inches is our routine. The energy required in this view will average 84 K.V.P., 30 ma. for 4 seconds. A lateral view is then taken by placing the patient in the center of the table and centering the tube over the inferior margin of the anterosuperior iliac spine. The patient is more easily placed in correct position on a curved table top. For the ateral view, a pillow is placed between the knees—it aids materially in preventing movement and is more comfortable. A separation of knees, in the lateral position, maintains the true conjugate diameter of the pelvis on the same plane. The exposure for the lateral view will average 84 K.V.P., 30 ma., 12 seconds.

There are no measurements taken of the patient or any markers placed on her. Films of the 14 × 17 inch size are used and the long diameter is placed transversely to the pelvis. In multiple pregnancy and

THE "PELVICEPHOLOMETER"

An instrument, the pelvicepholometer (Fig. 1), is used to measure the circumference of the fetal head and diameters of the maternal pelvis. This was constructed to more conveniently utilize a chart (Fig. 2) designed to correct linear and volumetric magnification. It consists of a small wheel (Fig. 1*a*), mounted on a shaft which by a worm gear mechanism turns a second shaft (*b*) upon which a pointer is mounted. The pointer (*c*) travels above the surface of a dial (*d*) upon which the chart is fastened. The small wheel (*a*) is run over the periphery of the object to be measured. The ratio between the wheel (*a*) and the second shaft is such that a pointer, of proper length for the chart, will travel over the same distance as the wheel (*a*).

The chart shows the figures at the periphery in centimeters. In the 360 degrees of this circular chart there are 60 divisions, representing 60 centimeters linear travel of

the wheel (*a*). Millimeter divisions are also shown (Fig. 1). The row of figures subjacent to the centimeter scale show the volume of a sphere, in milliliters, with a circumference of the corresponding measurement in centimeters. The third row of figures shows the volume of a sphere with a diameter measurement of the centimeter to which it is subjacent (Fig. 2).

The curved lines extending from the centimeter divisions to the center require some explanation. The linear magnification of an object as registered on the film will vary with the distance of the object from the film. When the tube-film distance is known this magnification can be calculated by various methods. It may be determined by geometry or by the use of a calculated scale such as Walton has used. The important data are the factors of linear magnification of different sized objects at different distances from the film. Table III shows the factor of linear magnification. This table was constructed in a manner similar to that used by Walton in the construction of his false centimeter scale, and compared with a geometrical calculation. The radial lines in the chart represent the plotting of polar co-ordinates. A plotting on a rectangular chart is shown in Figure 4. The mathematical formula will be reported in a later communication. The pointer (*c*) on the dial is a scale on transparent material. A line in the center is used for a straight edge and extends to the periphery of the chart. This scale represents the distance, in centimeters, of the object from the film when exposure is made.

READING THE FILM

Both dry films are placed on a view box and are interpreted as to the position of the fetus, presentation, engagement into the superior strait, fetal or maternal abnormalities of skeletal structures, etc. The circumference of the fetal skull (cranial) is then traced with the pelvi-

TABLE I.—VOLUME AND DIAMETER OF SPHERE-CIRCUMFERENCE GIVEN

Circumference	Volume	Diameter	Circumference	Volume	Diameter
15 cm.	56.8 cc.	4.77 cm.	33 cm.	606.0 cc.	10.50 cm.
15.5 cm.	62.8 cc.	4.93 cm.	33.5 cm.	636.0 cc.	10.67 cm.
16 cm.	69.0 cc.	5.09 cm.	34 cm.	662.0 cc.	10.82 cm.
16.5 cm.	75.7 cc.	5.25 cm.	34.5 cm.	693.0 cc.	10.98 cm.
17 cm.	83.0 cc.	5.41 cm.	35 cm.	721.0 cc.	11.13 cm.
17.5 cm.	90.5 cc.	5.57 cm.	35.5 cm.	755.0 cc.	11.30 cm.
18 cm.	98.0 cc.	5.72 cm.	36 cm.	788.0 cc.	11.46 cm.
18.5 cm.	106.5 cc.	5.88 cm.	36.5 cm.	820.0 cc.	11.62 cm.
19 cm.	115.4 cc.	6.04 cm.	37 cm.	855.0 cc.	11.78 cm.
19.5 cm.	125.0 cc.	6.20 cm.	37.5 cm.	889.0 cc.	11.93 cm.
20 cm.	135.0 cc.	6.36 cm.	38 cm.	924.0 cc.	12.09 cm.
20.5 cm.	145.1 cc.	6.52 cm.	38.5 cm.	961.0 cc.	12.25 cm.
21 cm.	156.4 cc.	6.68 cm.	39 cm.	1002.0 cc.	12.42 cm.
21.5 cm.	168.0 cc.	6.84 cm.	39.5 cm.	1042.0 cc.	12.58 cm.
22 cm.	180.0 cc.	7.00 cm.	40 cm.	1080.0 cc.	12.73 cm.
22.5 cm.	192.2 cc.	7.16 cm.	40.5 cm.	1122.0 cc.	12.89 cm.
23 cm.	205.8 cc.	7.32 cm.	41 cm.	1165.0 cc.	13.05 cm.
23.5 cm.	218.0 cc.	7.47 cm.	41.5 cm.	1204.0 cc.	13.20 cm.
24 cm.	233.5 cc.	7.64 cm.	42 cm.	1252.0 cc.	13.37 cm.
24.5 cm.	248.5 cc.	7.80 cm.	42.5 cm.	1293.0 cc.	13.52 cm.
25 cm.	263.0 cc.	7.95 cm.	43 cm.	1342.0 cc.	13.68 cm.
25.5 cm.	280.0 cc.	8.12 cm.	43.5 cm.	1390.0 cc.	13.84 cm.
26 cm.	296.0 cc.	8.27 cm.	44 cm.	1437.0 cc.	14.00 cm.
26.5 cm.	314.0 cc.	8.14 cm.	44.5 cm.	1487.0 cc.	14.16 cm.
27 cm.	333.0 cc.	8.60 cm.	45 cm.	1531.0 cc.	14.30 cm.
27.5 cm.	350.0 cc.	8.75 cm.	45.5 cm.	1588.0 cc.	14.47 cm.
28 cm.	369.0 cc.	8.90 cm.	46 cm.	1640.0 cc.	14.63 cm.
28.5 cm.	389.0 cc.	9.06 cm.	46.5 cm.	1692.0 cc.	14.79 cm.
29 cm.	412.0 cc.	9.23 cm.	47 cm.	1746.0 cc.	14.94 cm.
29.5 cm.	433.0 cc.	9.39 cm.	47.5 cm.	1803.0 cc.	15.10 cm.
30 cm.	455.0 cc.	9.54 cm.	48 cm.	1867.0 cc.	15.27 cm.
30.5 cm.	478.0 cc.	9.70 cm.	48.5 cm.	1922.0 cc.	15.43 cm.
31 cm.	502.0 cc.	9.85 cm.	49 cm.	1982.0 cc.	15.59 cm.
31.5 cm.	524.0 cc.	10.01 cm.	49.5 cm.	2044.0 cc.	15.75 cm.
32 cm.	552.0 cc.	10.18 cm.	50 cm.	2105.0 cc.	15.90 cm.
32.5 cm.	578.0 cc.	10.34 cm.			

TABLE II.—VOLUME OF SPHERE-DIAMETER GIVEN

Diameter	Volume
5 cm.	65.45 cc.
5.5 cm.	87.11 cc.
6 cm.	113.10 cc.
6.5 cm.	143.79 cc.
7 cm.	179.59 cc.
7.5 cm.	220.89 cc.
8 cm.	268.08 cc.
8.5 cm.	321.56 cc.
9 cm.	381.70 cc.
9.5 cm.	448.92 cc.
10 cm.	523.60 cc.
10.5 cm.	606.13 cc.
11 cm.	696.91 cc.
11.5 cm.	796.33 cc.
12 cm.	904.78 cc.
12.5 cm.	1022.70 cc.
13 cm.	1150.3 cc.
13.5 cm.	1288.2 cc.
14 cm.	1436.8 cc.
14.5 cm.	1596.3 cc.
15 cm.	1767.1 cc.

TABLE III.—FACTOR OF MAGNIFICATION OF LINEAR DIMENSIONS ON FILM, WITH OBJECT AT VARIOUS DISTANCES FROM FILM. TARGET-FILM DISTANCE, 30 INCHES OR 76.2 CENTIMETERS

Object-film Distance	Factor of Magnification	Object-film Distance	Factor of Magnification
5 cm.	1.07	20.5 cm.	1.370
5.5 cm.	1.078	21 cm.	1.380
6 cm.	1.086	21.5 cm.	1.395
6.5 cm.	1.093	22 cm.	1.407
7 cm.	1.101	22.5 cm.	1.420
7.5 cm.	1.110	23 cm.	1.433
8 cm.	1.118	23.5 cm.	1.445
8.5 cm.	1.126	24 cm.	1.460
9 cm.	1.136	24.5 cm.	1.476
9.5 cm.	1.142	25 cm.	1.490
10 cm.	1.150	25.5 cm.	1.505
10.5 cm.	1.160	26 cm.	1.520
11 cm.	1.170	26.5 cm.	1.535
11.5 cm.	1.180	27 cm.	1.550
12 cm.	1.188	27.5 cm.	1.565
12.5 cm.	1.198	28 cm.	1.581
13 cm.	1.207	28.5 cm.	1.600
13.5 cm.	1.216	29 cm.	1.615
14 cm.	1.225	29.5 cm.	1.630
14.5 cm.	1.235	30 cm.	1.650
15 cm.	1.245	30.5 cm.	1.670
15.5 cm.	1.256	31 cm.	1.688
16 cm.	1.266	31.5 cm.	1.705
16.5 cm.	1.277	32 cm.	1.725
17 cm.	1.288	32.5 cm.	1.745
17.5 cm.	1.299	33 cm.	1.765
18 cm.	1.310	33.5 cm.	1.786
18.5 cm.	1.320	34 cm.	1.808
19 cm.	1.330	34.5 cm.	1.830
19.5 cm.	1.342	35 cm.	1.850
20 cm.	1.356		

cepholometer on the film (for the sake of description) in the anteroposterior view, with the line on the pointer placed over zero on the chart at the beginning of the tracing. After completing the tracing of the circumference on the film, the spot at which the pointer rests is noted. This is the magnified circumference on the film in true centimeters. With any centimeter scale the distance of the fetal skull from the film in the anteroposterior view is determined by measuring on the film taken in the lateral view the distance from the mid-portion of the skull to the posterior border of the sacrum. To this measurement is added the distance from the table top to the film. This will represent in centimeters the approximate distance of the fetal head from the film in the anteroposterior view. In the average patient the soft tissue between sacrum and table top is about the linear magnification of the fetal head-film distance, using a 30-inch target-film technic. The corrected reading for the circumference is then made by shifting the dial or retracing pointer to the point where the subjacent radial curve is intersected by the figure on the pointer which indicates the approximate object-film distance. At the periphery of the chart, the straight line on the pointer will then be resting over the corrected reading. The circumference in the lateral view is then measured and the film-object distance determined by measuring from the center of the fetal head to the lateral border of the greater trochanter and adding the distance from the table top to the film. Again the linear magnification is found to be about equal to the soft tissue thickness.

The two readings will usually vary less than two centimeters. A mean circumference is determined. For the mean circumference there is a calculated volume in milliliters on the circular chart.

Now the anteroposterior diameter (true conjugate) of the pelvis is determined by tracing the small wheel from the anterosuperior border of the sacral promontory to the posterosuperior border of the symphysis. The correction of linear magnification in this plane is made by measuring the distance from the symphysis to the greater trochanter of the femur and adding

the table top-film distance. The correction is then determined and figures upon the dial show the true anteroposterior diameter. The third row of figures gives the volume in milliliters of a sphere of this measured diameter. The ischial interspinous diameter is then determined by tracing the instrument between the two ischial spines in a straight line and the distance of the spine from the film obtained from the lateral view. For this corrected measurement, there is a figure (on the dial) representing the volume capacity of a sphere of this diameter. A comparison can then be made between the volume in milliliters of the cranial skull and the volume capacity of the shorter diameter of the pelvis. If the position of the fetal head permits, *i.e.*, the cardinal diameters are not foreshortened by obliquity, the diameter may be taken, if desired, as advocated by others. Because it is a convenient distance this presentation has been made for a 30-inch target-film technic, although if desired any target-film distance technic can be used with appropriate correction chart on the dial.

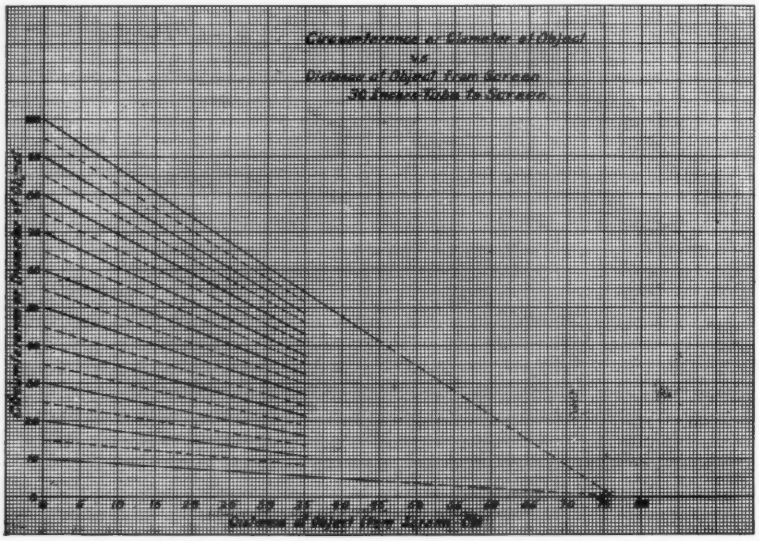

Fig. 4. A rectangular chart correcting two variables for comparison with Figure 2.

The body weight of the fetus is reported as the average weight for a known circumference of head (Table IV). The majority can be estimated within 8 ounces. The mean circumference of the occipito-frontal and suboccipito-bregmatic measurements will average two cm. greater in the new-

TABLE IV.—TABLE, SHOWING THE AVERAGE BODY WEIGHT FROM MEAN CIRCUMFERENCE MEASUREMENTS OF OCCIPITO-FRONTAL AND SUBOCCIPITO-BREGMATIC CIRCUMFERENCE, IN A NEW-BORN INFANT

Mean Circumference	Body Weight Pounds	Ounces
28 cm.	4	8
28.5 cm.	4	11
29 cm.	5	1
29.5 cm.	5	5
30 cm.	5	12
30.5 cm.	6	0
31 cm.	6	4
31.5 cm.	6	7
32 cm.	6	10
32.5 cm.	6	13
33 cm.	7	10
33.5 cm.	8	2
34 cm.	8	6
34.5 cm.	8	10
35 cm.	8	14
35.5 cm.	9	2
36 cm.	9	5
36.5 cm.	9	9

born than the bone measurements taken from films. This difference is due to the thickness of the scalp, which will average two millimeters. The actual volume of the fetal head must be determined by adding two centimeters to the measurement as read from the film. The weight table is constructed from measurements made from both molded and unmolded heads immediately after birth. The mean circumference refers to the occipito-frontal and suboccipito-bregmatic circumference measurements. The table is subject to correction after more data are obtained from a larger series of cases, from all sections of the country.

The rate of increase in the size of the fetal head has not heretofore been obtainable. The above technic makes it possible to obtain this information relative to the cranium of the fetus and when this has been determined in a great number of cases, it will be possible to state with fair accuracy the size and weight of the fetus at the time examined and at successive weekly intervals. The most probable optimal time for the examination is probably at the calculated end of the eighth month of gestation or at any time of suspected or anticipated disproportion.

RESULTS

Over sixty cases have been examined by the above technic. The mean circumference of the fetal cranium has been accurately stated to within one centimeter previous to delivery in over 85 per cent of the cases; the remainder were within two centimeters. The total weight was stated within eight ounces in over 85 per cent of the cases: the remainder were within one pound. This consecutive series represents various types of presentations as they occurred. Five caesarean sections, three multiple pregnancies, three cases of transverse position, and four of breech presentation are included in this group.

SUMMARY

A simplified technic for roentgen pelvimetry and fetal cephalometry is presented.

A circular chart which corrects two variables is presented with a new instrument, the pelvicepholometer.

The mean circumference of the fetal cranium is found to be a very dependable, accurate means of estimating the volume and is applicable for predicting the size of the fetus.

It is suggested that a comparison of the volume of the fetal head, calculated from the circumference, be made with the volume of a sphere calculated from a diameter measurement obtained from the smaller pelvic diameter. This comparative volume ratio is an index which will shift with the increase of the fetus and may well indicate the need for close observation of the patient.

We suggest a routine roentgen examination at some time during the last calculated month of gestation.

We wish to acknowledge the invaluable aid of Dr. Edward F. Buchner, Jr., in the development of this technic: his insistence upon more accurate mensuration prompted our efforts. We wish also to acknowledge with much gratitude the aid of Miss Amelia Wilson, x-ray technician, in the experimental work done; also to Mr. D. R. Swingle, B.S.E.E., and Mr. K. E. Hapgood, B.S.E.E., for their aid in checking the mathematical calculations.

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ENCEPHALOGRAPHIC EXPERIENCES: MEDICO-LEGAL DEDUCTIONS

By E. S. GURDJIAN, M.D., *and* H. A. JARRE, M.D., *Detroit, Michigan*

THE clinical value of encephalography, well performed and correctly interpreted, cannot be overestimated. The procedure has made possible many a correct diagnosis and prevented numerous useless cranial operations. Nevertheless, important points deserve further clarification, as one might easily realize from the discrepancies recorded in the literature.

Of all the various spaces demonstrable by encephalography only one system, the ventricular, is well known. Conceptions concerning the epi- and sub-arachnoid spaces and their physiologic interrelationship are at variance; sufficient information is not yet available about the fluid-equilibrium between cerebrum and pericerebral spaces under different physiologic and pathologic conditions. The work of Locke and Naffziger, done under technical difficulties on autopsy material, cannot remedy this situation. A wide divergence of opinion concerning the interpretation of peripheral collections of air, therefore, is understandable.

As a contribution to correct evaluation of encephalography we wish to present several points for discussion in this paper. We base our opinions on experiences with a fairly large amount of material from Grace Hospital and the Receiving Hospital of Detroit, Michigan.

Some physical factors influencing demonstrability of intracranial fluid-spaces and governing the distribution of the injected air.—The existence of a positive spinal fluid pressure enables us to remove part of this fluid in the usual manner, but a complete evacuation probably cannot ever be expected. Were this fluid contained in a cube, sphere, or a similar vessel, its evacuation would be simple; but the peripheral intracranial fluid spaces are most irregular, segmented, tortuous, shallow in parts, deeper in others, with most complicated intercommunicating channels of, in all probability, variable lumina. One cannot anticipate complete drainage of such a system by available methods. When the intracranial pressure has receded gradually to a low point, considerable fluid will always remain in corners, angles, and recesses of the subarachnoid spaces, and one would expect that admixture of air to such residues must produce variable bizarre and unusual lakes. The average amount of fluid obtained in adults is between 100 and 150 c.c.; of course, occasionally more can be withdrawn. Differences in substitution must of necessity produce different images and should be taken into consideration for interpretation, though widely applicable standardization of all technical procedures should be striven for.

The physical forces of capillary attraction and surface tension of necessity play a rôle in governing the distribution of air and fluid in these irregular peripheral spaces. Bubbles form, which may easily become trapped or imprisoned here and there and interfere with further flow of these media. Their presence alone may be sufficient to produce over-inflation of one sector and prevent the usual aëration of another. Thus forces come to play on the gelatinous consistency of the brain which lead to a more or less pronounced shoving or molding of this substance, the possibility of which, of course, is well known from observations of epi- or subdural hematomas. When, in addition, one considers that the amount of blood within the skull may undergo marked changes, then one conceives of the uncontrollable variability in pericerebral encephalographic images and the limitations of this diagnostic procedure.

In approximately 8 per cent of our patients no air was admitted into the ven-

tricles at the first encephalographic exploration though a sufficient exchange was performed. Quite a few of these patients were re-investigated: in some instances a second encephalographic attempt secured an entirely normal response, while in some others ventriculography was resorted to and either a normal ventricular system was found or occasionally an internal hydrocephalus.

The conclusion of a pathologic basal obstruction on the basis of a single encephalographic attempt would be regarded as hasty and premature. Such a final conclusion is justified only after positive ventriculographic demonstration of an internal hydrocephalus. Encephalographic non-visualization of the ventricular system may be the result of (*a*) incidental, non-significant obstruction; (*b*) pathologic occlusion, or (*c*) increased intracranial pressure of variable etiology.

The latter condition, operative in prevention of encephalographic ventricular visualization, was encountered five times in patients with tumors: a left temporosphenoidal, a frontal, a left parietal, a right thalamic tumor, a gumma of the right cerebellum and the fourth ventricle. In two of these cases a satisfactory demonstration was obtained subsequent to large exploratory decompressions, thus proving to our satisfaction that originally increased intracranial pressure prevented admittance of air beyond the basal cisternæ, and that reduction of this pressure by operation corrected this original difficulty. Variations in intracranial pressure under different physiologic and unphysiologic influences deserves further study.

Finally, one should admit that adhesions of the pia arachnoid, as demonstrated at biopsy or autopsy, may explain some cases of non-admission of air to any or all segments of the cerebral fluid-systems. However, in recognition of the conditions discussed concerning the many possibilities of interference, one should be reluctant to quickly and frequently render such a diagnosis on encephalographic evidence only.

Summary.—The following physical factors and forces have to be considered in encephalographic interpretations:

(1) Character and structure of the peripheral fluid spaces;

(2) Quantity of air exchanged for fluid;

(3) Capillary attraction and surface tension;

(4) Gelatinous consistency of the brain;

(5) Variable intracranial blood-content and cerebromeningeal hydration;

(6) Basal obstruction, incidental or pathologic;

(7) Abnormally increased intracranial pressure;

(8) Adhesions of pia arachnoid.

Usually several of these factors are co-operative in the production of pictorial variants.

Plates I and II were chosen to demonstrate fallacies of encephalography such as might arise from non-consideration of some of the points stressed.

Plate I. Variations resulting from fractional fluid-air exchange and molding of the cerebrum (three cases).—In Figures 1, 2, and 3 there is an exchange of 50, 100, and 145 c.c., respectively. Note the increasing visibility of the peripheral spaces, while the ventricles are not filled—they may have been collapsed and thus allow the escape of air into the subdural spaces, with subsequent dislocation of the brain. Air also is trapped between the hemispheres. This demonstrates the incidental asymmetrical midline shift of the hemispheres—molding of the gelatinous cerebral substance under the influence of unequal peripheral pressure.

In Figures 4 and 5, the method of fractional injection of air was also used. There is a marked difference in cortical markings with varying degrees of insufflation. In Figure 4, one is tempted to assume the absence of air over the hemispheres after the initial injection of 50 cubic centimeters. In Figure 5, after injection of an additional 70 c.c. of air, the picture was changed materially. In this film there is seen a marked collection of air over both hemispheres. The same condition prevails in Figures 6 and 7. In the former an injec-

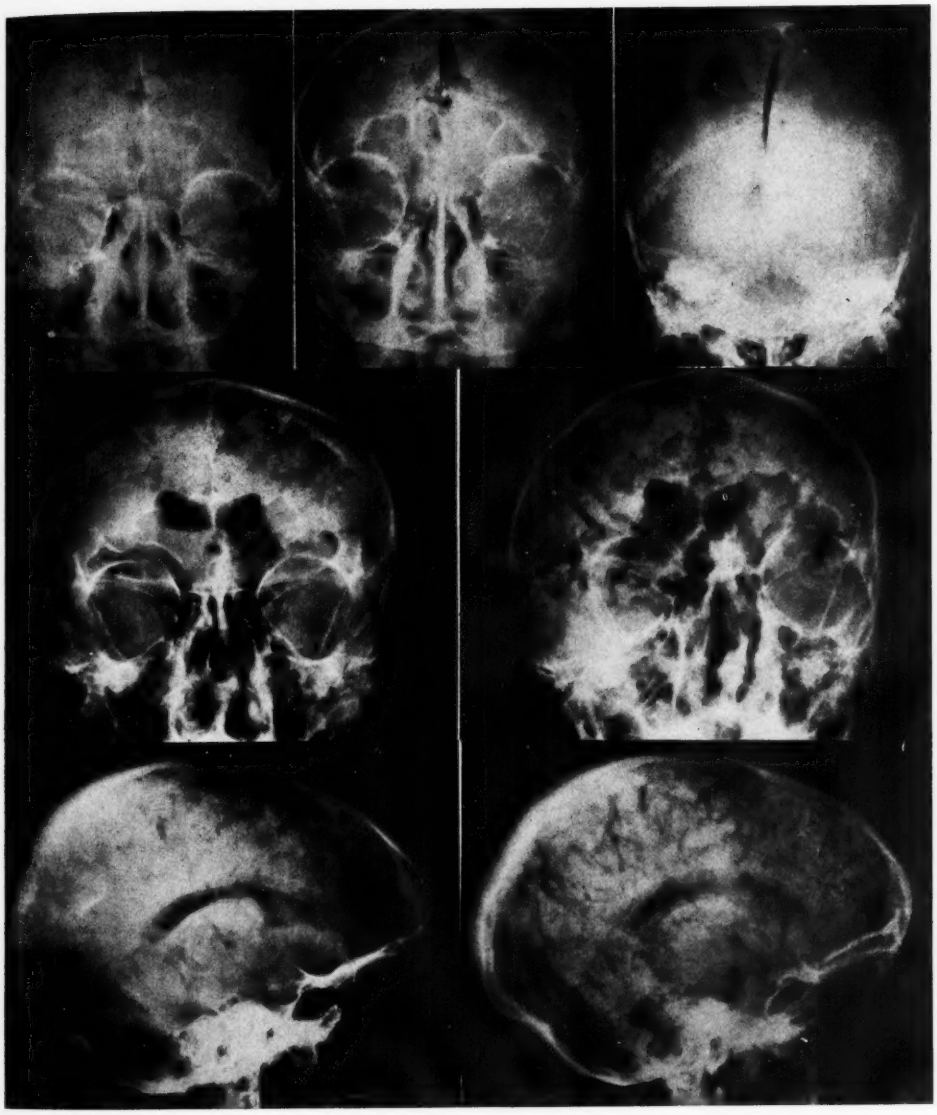

Plate I.

tion of 60 c.c. of air shows little cortical markings, but an additional injection of 70 c.c. shows a marked contrast to Figure 6. These films prove beyond doubt that in different hands encephalography may produce varying interpretations because of technical variations.

Plate II. Figures 1, 2, 3, and 4 show incidental, uncontrollable subdural escape of air in two cases. As a result of this accident, spaces normally shown, especially the ventricles, are not demonstrated at all or but incompletely, poorly, or asymmetrically outlined. The ventricles probably collapse more or less completely in such instances, thus creating the space for the peripherally depressed brain substance. This occurrence should not be misinter-

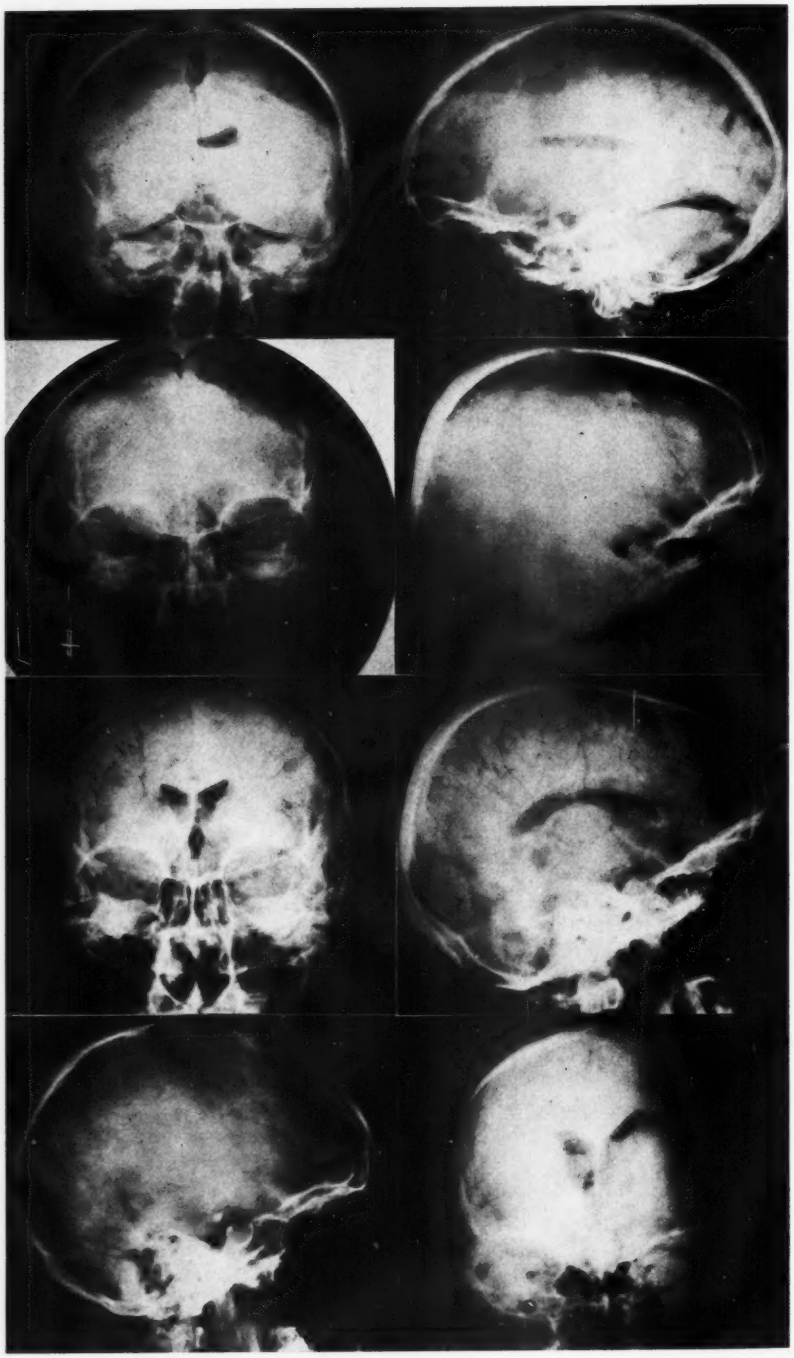

Plate II.

preted as cerebral or cortical atrophy. Figures 5 and 6 show the result of a second encephalographic exploration on the patient shown in Figures 3 and 4. These images must be regarded as normal. A comparison between the second and third row of these illustrations must caution every interpreter not to draw hasty conclusions. Figure 7 is a roentgenogram of a case of non-admission of air beyond the basal cisternæ because of the presence of a supratentorial brain tumor (left temporosphenoidal astrocytoma) producing abnormally high intracranial pressure. Figure 8 shows the findings in a successful encephalography following decompression, in a case of melanosarcoma of the left frontal lobe. No demonstration of intracranial fluid-spaces could be obtained before reduction of abnormally high intracranial pressure.

Of patients investigated encephalographically four groups attract particular interest on correlation of clinical and encephalographic observations. These are: (*a*) cases with marked clinical manifestations of severe cerebral damage but with little or no encephalographic evidence of disease; (*b*) cases with clinical manifestations of mild, non-incapaciting cerebral damage but with pronounced, striking encephalographic defects; (*c*) cases in which the encephalographic demonstation of cerebral pathology is well in proportion to anticipations on clinical evidence; (*d*) cases in which the type of pathologs could only be found by radiographic procedure.

(*a*) *Case with marked clinical manifestations of severe cerebral damage but with little or no encephalographic evidence of disease.* Such patients are encountered quite frequently, but concerning this group especially one can find a wide variance of opinion in the literature. For instance, Stone and Jones find normal encephalograms in 60 per cent of cases with traumatic epilepsy, while in the opinion of Pendergrass and Fay some kind of pathology can be shown roentgenologically in nearly all patients with convulsive states. Winkler reports normal radiologic findings in more than 50 per cent of his patients afflicted with feeblemindedness.

Plate III shows records of six such patients: (Fig. 1) Little's disease with marked quadraplegia, birth injury—normal encephalogram. (Fig. 2) Severe left hemiplegia following skull injury; mild ventricular asymmetry; no air in subarachnoid spaces. (No repetition of procedure so far.) Roentgenologic findings appear quite insignificant. (Fig. 3) Marked feeblemindedness; age 16, mental age, 6; normal encephalogram with somewhat large but well-formed ventricles. (Fig. 4) Traumatic epilepsy with frequent, severe attacks; the encephalogram probably would be regarded as normal by many interpreters; one might, however, draw attention to somewhat noticeable drainage of peripheral fluid-spaces. (Fig. 5) Left hemiplegia, apoplexy; mild ventricular enlargement with slight asymmetry. (Fig. 6) Traumatic epilepsy with frequent severe attacks; cortical defect in right parietal area; slight ventricular asymmetry.

May we repeat, these cases illustrate an incongruity, namely, severe, incapacitating cerebral diseases on one hand, normal or but slightly abnormal encephalograms on the other. The seriousness of the clinical condition is not at all reflected in the roentgenogram. Normal or nearly normal encephalograms by no means indicate normally functioning brains or absence of nervous disease or headache.

(*b*) *Cases with clinical manifestations of mild, non-incapacitating cerebral damage but with pronouced, striking encephalographic defects.*

Plate IV shows records of four such patients: (Fig. 1) Occasional mild epileptic spells, months apart, during the last five years; no complaints of headaches or dizziness; patient is an active preacher, apparently satisfactory for the needs of his congregation. Compounded, depressed cranial fracture fourteen years previously; syphilis under therapeutic control. Large cranial defect; corresponding cerebral defect; internal hydrocephalus of moderate degree. (Fig. 2) Since en-

Plate III.

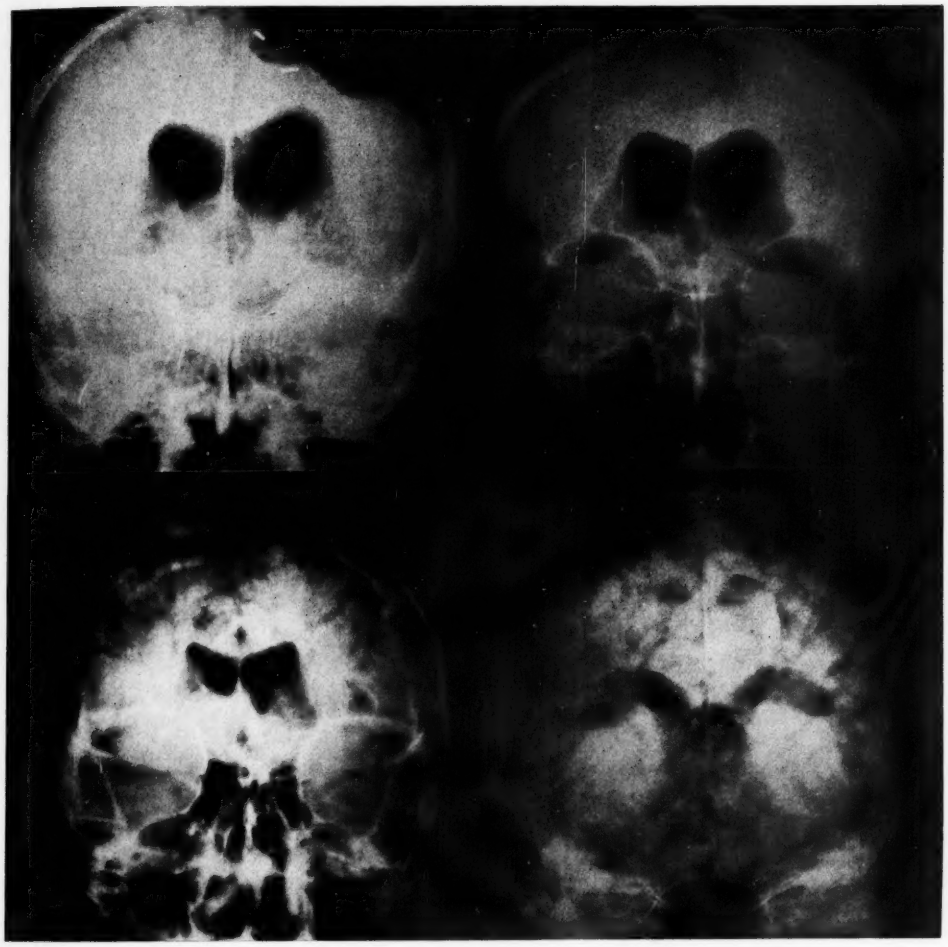

Plate IV.

cephalography was done, the patient (an active housewife) has had normal mentality; no complaints of any kind; six weeks before, a cranial fracture with temporary marked disorientation and psychosis; investigation in search of a possible subdural hematoma: internal hydrocephalus of moderate degree; no peripheral fluid-spaces outlined. (Fig. 3) Occasional headaches and dizziness; patient (a policeman on active duty) suffered a cranial fracture three years prior to investigation; no improvement from encephalography; 230 c.c. of fluid removed; cerebral atrophy of moderate degree. (Fig. 4) Occasional attacks of headaches and dizziness for twelve years, clinically improved since investigation; encephalitis fourteen years before; patient was an active police-lieutenant, who performed his duties well enough to earn repeated promotions during the period of complaints; marked cerebral atrophy.

May we emphasize the lesson to be learned from this group of patients: encephalographically shown marked cerebral defects are not necessarily coincident with similarly marked mental or nervous deficiency; one cannot judge a patient's mentality or brain function from his en-

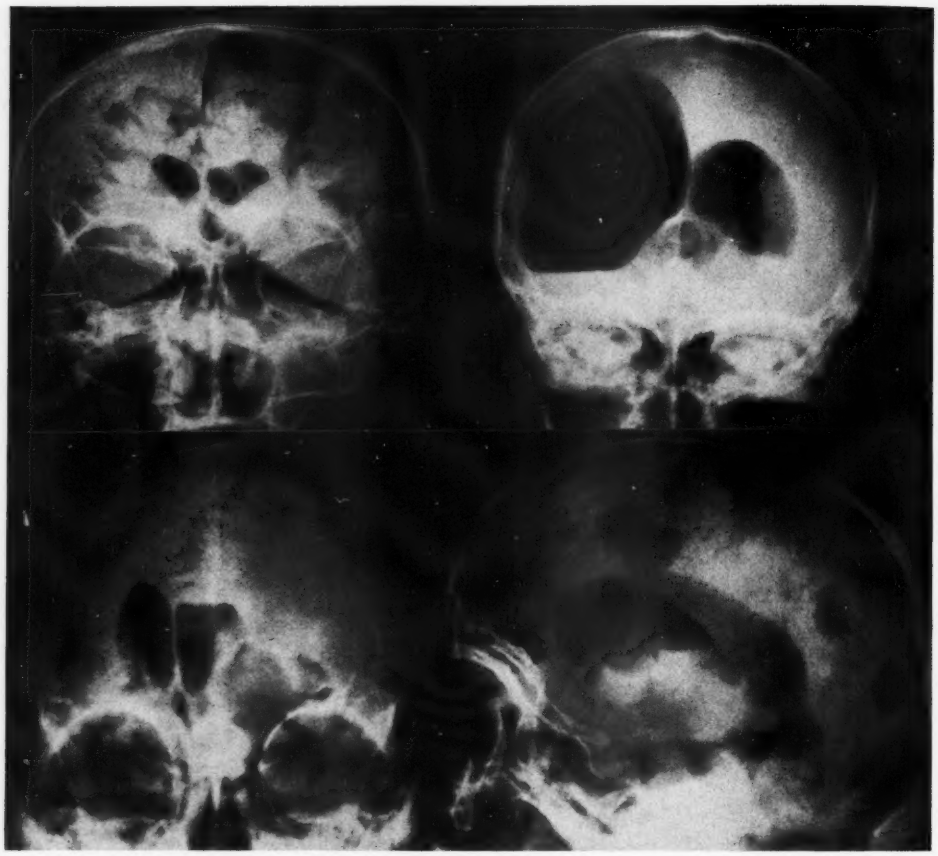

Plate V.

cephalographic records.

In pronounced contrast to these two groups of patients, who showed decided disproportion between clinical and encephalographic symptoms, we have to demonstrate two additional groups, which are of interest in that they chiefly justify the employment of this diagnostic method.

Plate V illustrates cases in which (*c*) *encephalographic demonstration of cerebral pathology is well in proportion to anticipations on clinical evidence.*—(Fig. 1) Right hemiplegia due to a vascular accident; marked atrophy of left hemisphere with some asymmetry and distortion of ventricles. (Fig. 2) Spasticity on both sides, more marked on left; aphasia; patient bedridden; cranial fracture with brain damage two years before. Marked asymmetrical internal hydrocephalus; no air over surfaces of hemispheres. (Figs. 3 and 4) Patient's clinical condition suggestive of progressive left parietal lesion; marked shift to the right; obliteration of posterior horn of the left lateral ventricle; tumor in the left posterior parietal region.

Plate VI (*d*) *records of a few selected cases, in which the type of pathology present could be found only by radiographic procedure.* (Fig. 1) Left-sided hemiplegia; right parietal porencephaly resulting from birth injury. (Fig. 2) Epilepsy; mental retardation; internal hydrocephalus; so-called fifth ventricle. (Fig. 3) Mild traumatic epilepsy; gunshot injury sixteen years before; entirely

symptomless for twelve years, since which time there have been occasional epileptic attacks; porencephaly involving the right frontal lobe.

DISCUSSION

It is apparent from the preceding demonstration that encephalography is useful only in conjunction with a careful neurologic evaluation. Such a study will eliminate from this type of investigation all patients offering a clear-cut clinical diagnosis or promising no information from the roentgenologic search, which, after all, is not without inherent distress and danger.

Genuine brain damage may not be demonstrable by visible findings in the encephalogram. Encephalographic records, on the other hand, may show relatively extensive pathologic processes in the absence of much clinical evidence for such findings. The possibility of technical accidents with resulting bizarre manifestations in the encephalogram also causes much confusion. Patients with deteriorating mentality may present, in encephalograms, a variety of changes irrespective of clinical manifestations. For instance, in epilepsy we may find any of the following abnormalities: enlarged ventricles; asymmetrical ventricles; porencephaly; varying degrees of enlargement of subarachnoid channels; lack of air in subarachnoid channels; a combination of any of the above; perfectly normal encephalographic images. It is evident that with so many possibilities of explanation for the causation of the pathologic basis of epilepsy, the investigator's subjective preferences in interpretation are given a wide leeway.

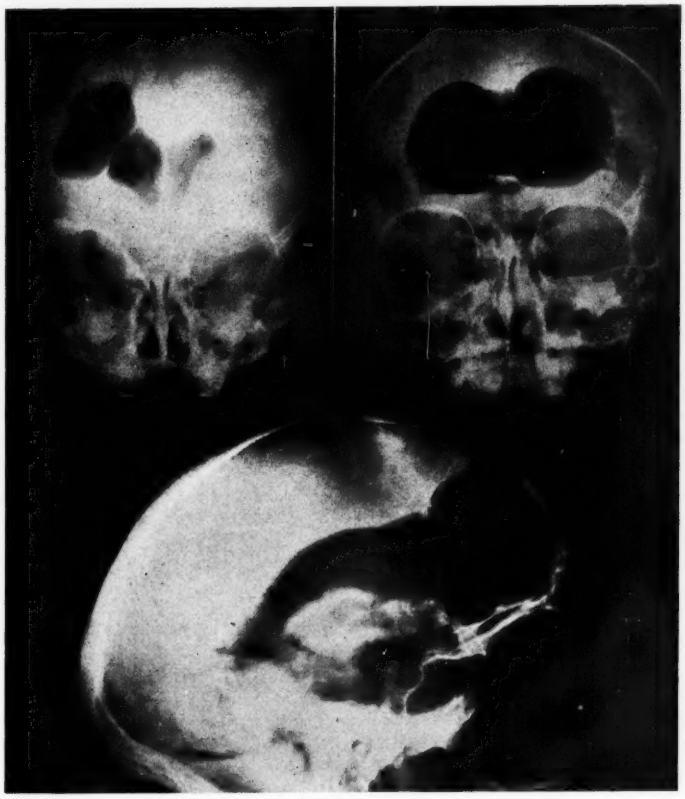

Plate VI.

Traumatic epilepsy is only one example; the same is true of a number of other conditions for which patients are treated by encephalography. It is pertinent, therefore, to state that encephalography constitutes a diagnostic procedure which may or may not be of help in the diagnosis; it furnishes part of the material for a diagnosis but is not the diagnosis *per se*.

Encephalographic reports are based on variations in the distribution of air in the ventricles and the subarachnoid channels. In a satisfactory encephalogram the study of the ventricular cavities is most reliable and it is felt that it should be the basis for pathologic classification. The subarachnoid spaces may present the following variations: (1) shadows only in the basal cisterns; (2) over the convexity of the hemispheres (the latter may show different degrees of insufflation varying from few blood-vascular and gyral markings to large confluent masses of air over one or both hemispheres); (3) demonstration of intercommunicating channels.

Diagnoses based on changes in ventricular outlines are trustworthy. The variability of the subarachnoid spaces, however, represents a difficult interpretative problem, especially in the presence of normal ventricles. Pia-arachnoiditis should be assumed only hesitatingly and requires corroboration by histologic study. Too much depends on uncontrollable physical factors to make this diagnosis justifiable in many instances. Localized, circumscribed arachnoid adhesions may logically be assumed more readily as sequelæ to compound cranial fracture with cerebral laceration than generalized arachnoiditis for the explanation of headaches and dizziness of undetermined cause. Words of caution are also timely concerning the so-called brain atrophy: in the presence of normal ventricles one should be most careful with the analysis. The demonstrability of subarachnoid channels varies with time and individuals; wide subarachnoid channels are not necessarily pathologically enlarged pathways. They are larger, as a rule, in the anterior parts of the skull than posteriorly, but why they should not show in posterior segments, if only a complete substitution of air for fluid were obtained, is not explainable. There is no reason why the presence of air in the island of Reil should be considered evidence of brain atrophy, as long as structural conditions of the meninges in this turned-in portion are not different from any other superficial ones. Non-aëration of this recess should attract at least as much attention as aëration. To establish an arbitrary rule as to which surface-portion of the brain should be found aërated and which should not, seems rather premature. When large air collections are found over one or both hemispheres and the ventricles are not seen, the probability of an artefact becomes great—the brain often has collapsed into the ventricular spaces, the elimination of which has created room for the peripheral accumulations of gas. In such a case, the encephalographic procedures should be repeated. Yet, after all, a well directed study of all subarachnoid channels is most valuable as one may readily judge from the work of Stone and Jones and also of Dyke.

Gradually we will learn more about the significance of some of the encephalographic findings which now are poorly understood; especially we shall try to find out to what extent demonstrable cerebral deficiency is compatible with the patient's earning ability. At present, we admit that enlargement of the ventricles is pathologic; however, it may not be incapacitating at all, as shown above. Brain trauma may cause pronounced defects and distortions, yet the lack of clinical symptoms often is astonishing. Undoubtedly, therefore, ventricular deformity in certain cases is compatible with good health and average wage-earning ability. As concerns the subarachnoid spaces, we have demonstrated that patients with marked deviations from the normal are able to carry on satisfactory, remunerative work for years, while others with normal structural appearance are invalids.

We must urge great caution, therefore,

in the judicial use of encephalograms before any tribunal. We must realize that encephalograms are not diagnoses—that they are merely a part of the material for such, like any other roentgenogram. They may either be of decisive importance for a diagnosis, or irrelevant. A positive clinical diagnosis may not need encephalographic support; a doubtful clinical differential diagnosis may be decided by it, or not—often enough not. To establish the genuineness of complaints or malingering, careful detective work and cinematography may be more important than encephalography. Mental ability certainly cannot be demonstrated by this method, neither can earning capacity be established or the progression of changes be predicted on its basis. A normal encephalogram should not be construed as indicative of malingering, and a pathologic encephalogram does not necessarily substantiate complaints.

SUMMARY

1. Physical factors which influence encephalographic demonstration of intracranial fluid-spaces and govern the distribution of the injected air are discussed. Failure of recognition of these forces may lead to erroneous interpretations.

2. Incidences of disproportion between neurologic manifestations and encephalographic findings are shown—cases with marked clinical evidence of severe incapacitating cerebral disease and relatively normal encephalograms, and also cases with the reversed relationship.

3. Observations are recorded in which encephalographic demonstration is well in proportion with clinical manifestations, or which could not have been made by any method other than encephalography.

4. The necessity of careful correlation of all clinical-neurologic and encephalographic data is stressed and a warning is sounded against the indiscriminate judicial use of encephalograms, with neglect of clinical neurology.

CANCER METASTATIC TO BONE[1]

By WALTER A. FORT, M.D., Lieutenant Commander, Medical Corps, U. S. Navy,
Mare Island, California

From the files of the radiological departments of Stanford University Hospital and San Francisco County Hospital, San Francisco California*

WHEN cancer cells become detached from the primary growth to circulate in the blood and lymph, it is quite logical to expect that some of them will lodge in bony structures. Autopsy reports lead one to believe that this actually occurs much more frequently than we once supposed. The fact that the condition is often unrecognized antemortem is probably due to several factors, some of which are as follows:

1. Considerable proliferation of the transplanted cancer is usually necessary before signs or symptoms appear.
2. Small lesions of bone are difficult to detect in the roentgenogram.
3. In advanced cases of cancer, with general metastases, it often seems superfluous to search for bony invasion.

A wide variance of percentages of incidence for bone invasion would be obtained by a clinic which searched the skeleton for purposes of confirming the diagnosis, and by an institution which observed cases in the late stages of the disease. This study, therefore, makes no attempt to gauge the incidence of metastases to bone. It merely attempts to point out the favorite locations for transplants in bone by various types of cancer and to show that practically any type will grow in bony tissue in some patients.

The appended table presents 259 cases of carcinoma, 28 cases of other types of cancer, and 21 unidentified types that showed roentgen evidence of metastasis to bone.[2] A comparison with some of the reports from other sources is instructive.

Sutherland, Decker, and Cilly (1) reported 1,032 cases of cancer, observed at the Mayo Clinic, which showed metastatic lesions in bones (Series I). Copeland (2) reported 334 cases of cancer with bone metastasis, observed at the Johns Hopkins Hospital (Series II).

In Table I, some of the more important observations of the above mentioned observers are compared with ours (Series III).

TABLE I

Primary	Series I	Series II	Series III
Breast	38%	30%	36%
Prostate	28%	40%	16%
Lung	1%	1%	5%
Kidney	5%	6%	2%
Thyroid	2%	2%	1%
Stomach	2%	2%	1%
Colon	1%	1%	2%
Uterus	2%	1%	4%
Bones Involved in Order of Frequency	spine pelvis femur ribs skull	spine pelvis femur skull ribs humerus	pelvis spine ribs femur skull scapula clavicle humerus

The following are among the more interesting cases of our series.

Case 1. Sarcoma, primary, in the rib of a 25-year-old male, with metastasis to skull, pelvis, ulna, and other long bones. This was a slow-growing tumor. Several metastatic foci in the lungs were calcified. Microscopic sections from autopsy material suggested angio-sarcoma in some tissues and fibro-chondro-sarcoma in others.

[1] Work done as part of graduate instruction in Radiology at Stanford University School of Medicine, based on material at Stanford University Hospital, Department of Radiology, and the Stanford University Medical Service, San Francisco Hospital, Department of Public Health of the City and County of San Francisco.

* The opinions or assertions contained in this article are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department of the Naval Service at large.

(*Signed*) W. A. FORT

[2] Metastases are listed in all places found, but undoubtedly occurred in other bones and were not discovered because (1) they were too small to be identified; (2) no examination was made of that part of the skeleton.

Case 2. Carcinoma of the breast with only one bone metastasis—in the mandible, with fracture.

Case 3. Carcinoma of the breast with one bone metastasis—in the clavicle, with fracture.

Cases 4, 5, 6. Three cases of congenital hemolytic jaundice, with widespread bone lesions (see Table I). Two of these were in the same family.[3]

Case 7. Malignant melanoma, primary in the skin of the deltoid region, with metastasis to the third lumbar vertebra. The sections of this growth were those of sarcoma, but there was some dispute as to type.

Case 8. Adamantinoma, with large solitary metastasis to the pelvis. There was a pathologic fracture through the acetabulum. Autopsy revealed a few

[3] Congenital hemolytic jaundice has been included in this study because of the peculiar bone changes which are obviously dependent upon overgrowth of marrow and not upon altered osseous metabolism. This condition is probably not cancer.

TABLE II. TABULATION OF 308 CASES OF CANCER METASTATIC TO BONE

	Primary	No. cases	Metastatic to: Pelvis	Spine	Ribs	Femur	Skull	Scapula	Clavicle	Humerus	Radius-ulna	Tibia-fibula	Mandible	Metacarpal	Metatarsal	Sternum	Sup. maxilla	Malar	Productive[4]	Destructive
Cancer (Carcinoma)	breast	112	63	69	63	28	16	10	13	4	2	3	3	1		1			12	100
	prostate	52	50	18	9	17	1	2	1	1									35	17
	origin unknown	19	10	11	2	2	2	2	1	2									2	17
	lung	16	3	3	10	1	1	1	1	1									1	15
	kidney (hyperneph.)	8	3	1	2	1	1		1										2	6
	uterus (cervix)	7	4	1	1	1	1												1	6
	uterus (body)	6	4	2															1	5
	colon	5	2	2			1	1												5
	thyroid	4	2	1	1		2	1		1										4
	parotid	4		2	1		1		1		1								1	3
	rectum	3	1	2																3
	bladder	2	2																	2
	liver	2	1		2															2
	testes (teratoma)	3	3	1																3
	g.-i. tract (unknown)	2	1	2				1												2
	pharynx	2	1				2													2
	stomach	2	1	1																2
	esophagus	1		1																1
	small intestine	1								1										1
	pancreas	1	1																	1
	skin (melanoma)	1		1																1
	orbit (melanoma)	1					1													1
	larynx	1		1																1
	nasopharynx	1	1			1													1	
	lachrymal gland	1					1													1
	submax. gland	1											1							1
	mandible (adamantinoma)	1	1		1															1
	Total	259	154	119	92	51	30	18	18	10	3	3	4	1		1			56	203
Cancer, generalized	multiple myeloma	14	9	4	5	5	9	3	2	1		1	1							14
	leukemia	3				1			1						1				1	2
	Hodgkin's disease	3	1	2																3
	con. hem. jaundice	3	2	1	2	1	3	1	1	1	2	2		1					2	1
	Total	23	12	7	7	7	12	4	4	2	2	3	1	1	1				3	20
Cancer, miscellaneous	lymphosarcoma	1				1														1
	lymphoblastoma	1	1	1	1	1	1	1	1	1										1
	sarcoma, rib (fibrochond., angio.)	1	1			1	1			1	1									1
	endothelioma, femur	1	1			1														1
	neuro-fibroma, adrenal	1			1		1										1	1		1
	multiple unidentified tumors	21	10	10	5	2	5	1	1	1			1						2	19
	Total	26	13	11	7	6	8	2	2	3	1		1				1	1	2	24
	Grand Total	308	179	137	106	64	50	24	24	15	6	6	6	2	1	1	1	1	61	247

[4] A few cases exhibiting both productive and destructive lesions are grouped under the productive type.

small lesions in the ribs. No other metastases were found.

Case 9. Endothelioma, primary in the femur, with metastasis to femur and pelvis.

Case 10. A patient with two primary carcinomas, one in the lung and the other in the uterus, with metastases to bone from each. This patient also had Paget's disease of the femora (autopsy-proven).

CONCLUSIONS

1. Carcinoma of the breast and prostate are responsible for from 50 to 70 per cent of all cancer metastatic to bone.

2. Bone transplants from hypernephroma, carcinoma of the colon, thyroid, lung, and uterus, are fairly common.

3. Metastasis to bone from sources other than the above is not common.

4. Metastasis to bone from skin cancer is rare.

5. The pelvis and spine are the favorite locations for bone metastases of all kinds. Next to these, cancer prefers the ribs, femur, and skull.

6. Osteoclastic lesions are about four times as frequent as the osteoplastic type. In carcinoma of the prostate, productive types are about twice as frequent as the destructive.

The author is deeply indebted to Professor R. R. Newell and the Staffs of the radiological departments of Stanford University and San Francisco County Hospitals for their advice and assistance.

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THE TREATMENT OF EPITHELIOMA OF THE CHEEK[1]

By GEORGE E. PFAHLER, M.D., Sc.D., *Philadelphia*

IN general, cancer of the mouth is one of the most painful, distressing, and fatal diseases known when it has reached an advanced stage. On the other hand, it is a disease that is easily observed by both the patient and the physician. It causes symptoms early and, therefore, should be recognized in its earliest stages. In fact, in my opinion, the lesions that precede cancer should be treated thoroughly and skillfully, and I believe that for the most part, cancer of the mouth can be prevented. In spite of the fact that cancer of the mouth can be prevented, and in its earliest stages can be cured, it remains one of the most frequent and fatal types of cancer. According to Ewing, in frequency, it has been placed second by Jessett, third by Jacobson, and fourth by Winiwarter.

I quote Ewing as follows: "The failure to recognize the significance of early or precancerous conditions, temporizing with small but fully developed lesions, and an extravagant sacrifice of tissue in mild cases, are common errors committed in the case of these patients, and are largely responsible for the ultimate mortality and for that dread of the disease which leads many to conceal its existence as long as possible."

I believe that if it can be made known that the precancerous lesions and the early cancers of the mouth can be cured by irradiation with no pain or by simple electrocoagulation, plus thorough and skillful irradiation, that we will be taking a very long step toward the elimination of the fear of this disease, and will prevent many of the deaths that are now occurring. Warren, Butlin, and Meller give a mortality of this disease at present of 75 to 90 per cent. In my opinion, 75 per cent of these cases should get well if treated completely and thoroughly at the beginning. Such results, however, demand the thorough cooperation on the part of both the public and the physicians.

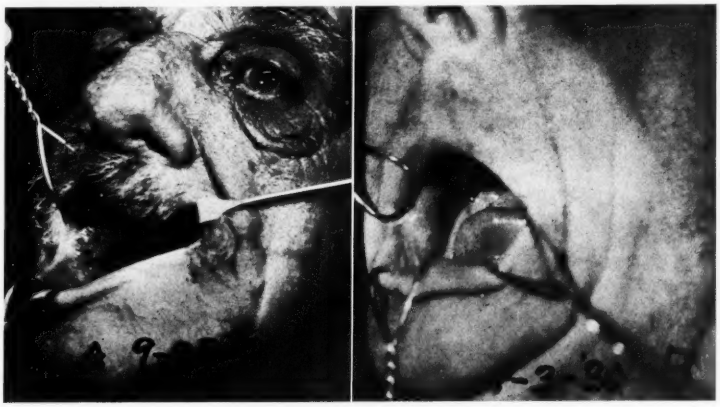

Fig. 1-*A*. Case 1. Shows the cancer involving the inside of the right cheek and also extending down to and involving the alveolar process, and the ramus of the jaw (Sept. 23, 1929).

Fig. 1-*B*. Case 1. Shows the mouth entirely well: remained well for four years, after which time the patient died of some hemorrhage from the bowel, cause unknown. (Photograph April 3, 1930.)

Epithelioma of the Mucous Membrane of

[1] Read by title before the Radiological Society of North America, at the Twentieth Annual Meeting in Memphis, Tenn., Dec. 3–7, 1934.

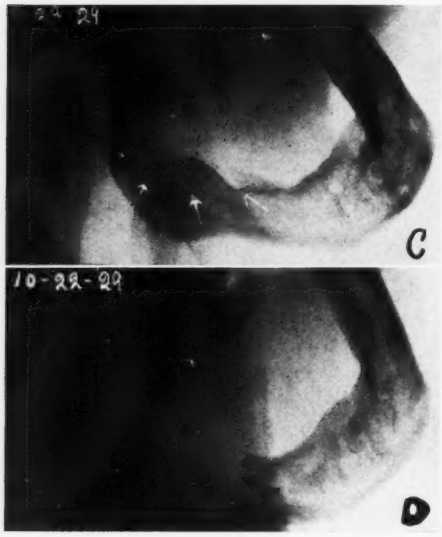

Fig. 1-*C*. Case 1. Shows the carcinoma involving the alveolar process and the ramus of the jaw, extending beneath the inferior dental canal.
Fig. 1-*D*. Case 1. Shows the resection of the ramus and the posterior portion of the mandible, with remaining bone healthy.

the Cheek.—It is self-evident that an epithelioma which involves the skin externally must be treated on the same principles which apply to any other skin cancer. Generally speaking, these lesions on the skin are of the basal-cell type, but occasionally one finds a squamous-cell type of epithelioma in this region. Then the neighboring lymphatics must be treated thoroughly, just as must be done in any other case of squamous-cell carcinoma. Because of the possibility of squamous-cell carcinoma, even when dealing with cancer of the skin of the cheek, it is my practice to do a biopsy, and then destroy the lesion by electro-desiccation, to be followed by local applications to the extent of 100 to 400 per cent of an erythema dose, using x-rays or radium according to the indications. Only in patients on whom the cosmetic results are of special importance, do I attempt to treat this entirely by irradiation, because of the fact that I like to get a biopsy. If skin cancers are thoroughly treated while only the skin is involved, then practically all can be cured.

The title of this paper is intended to call attention particularly to the *epitheliomas involving the mucous membrane.* These lesions are always serious in character, always of the squamous-cell type and, therefore, need extensive irradiation of the neighboring lymphatics. Generally, if not always, they begin as the result of a local irritation, such as is caused by the repeated biting with sharp-edged teeth. These teeth may be sharp either from necrosis, or from being worn down in the ordinary course of chewing. I believe, however, that in all cases in which a patient is biting the cheek, a sharp-edged tooth is present, which may not be easily found. If the teeth are old and jagged, one may have this chronic irritation even without biting the cheek. Commonly, such mechanical irritation is associated with that caused by the use of tobacco in excess, either smoking or chewing. I have seen these epitheliomas develop directly in the cheek where the patient was in the habit of holding his quid.

Certainly, such irritation does not develop from a moderate amount of smoking or moderate amount of chewing, but when either is continued over a period of 10, 15, or 30 years, it leads to the development of keratosis or perhaps only whiteness of the mucous membrane, which gradually becomes thickened and ulcerated and develops very slowly. However, a carcinoma may develop in the cheek without the formation of a leukoplakia, the absence of which does not rule out the diagnosis of carcinoma. Syphilis may be an underlying cause, therefore, when a lesion is present in the cheek, a positive serologic test does not exclude carcinoma. When there is any doubt, a microscopic examination should be made. Before taking these biopsies, which I make my routine, we give preliminary irradiation to the extent of at least one erythema dose.

The slowness with which an epithelioma on the inside of the cheek develops leads to carelessness and delay on the part of the patient, and sometimes, on the part of the attending physician, and an early and easily curable case becomes incurable.

These patients should not have the lesions in the cheek treated repeatedly by any form of caustic such as carbolic acid or nitrate of silver. In the earliest stages, when only a whiteness of the mucous membrane is present, it may be sufficient to remove the cause whether it be from tobacco, mechanical, chemical, or bacteriologic irritation.

Fig. 2-*A*. Case 2. Lateral view, showing complete healing in the case of a carcinoma involving the inside of the cheek and the alveolar process. Treated by irradiation, then electrocoagulation, on Nov. 23, 1918, followed by resection of the jaw and a plastic operation. Patient still well, 16 years later.
Fig. 2-*B*. Case 2. Shows anteroposterior view of the same case.

When one is dealing with a fully developed epithelioma of the cheek, the problem is very serious. If the lesion is malignant, small local surface destructions by electrodesiccation on the inside of the cheek are likely to be a failure, because the disease commonly extends more deeply than is estimated. The associated congestion that follows such destruction leads to the rapid development of the carcinoma, unless it is thoroughly controlled by sufficient irradiation. I have had success in the treatment of these lesions when the entire cheek was excised but at the present time, when one can use sufficient gamma irradiation from radium, or make use of highly filtered high voltage x-rays, I believe that electrocoagulation will probably rarely be necessary. Where the disease has extended from the cheek into the alveolar process, and especially when it has reached the inferior dental canal, it is often advisable to resect a part of the lower jaw, going well beyond the diseased area, as is indicated by the following case.

Case 1. Male, aged 74 years, was referred by Dr. J. M. Schildkraut, of Trenton, N. J., on Sept. 23, 1929, because of carcinoma involving the entire inside of the right cheek, and associated with destruction of the alveolar process and the ramus of the jaw. The disease had extended below the inferior dental canal. For approximately 55 years, the patient had smoked a pipe almost continuously while at work. He had developed some kind of a lesion in his right cheek five years previously, at which time he was ordered to stop smoking. He had an operation on the cheek and cheek bone, the latter having been scraped by the attending physician. This seemed to be followed by recovery lasting a short time, when a recurrence developed. At the time of coming to me for treatment, he was still smoking moderately. In addition to the disease involving the cheek and the jaw bone, he had a chain of lymph nodes extending along the sterno-cleido-mastoid muscle, which were dense and about the size of a pea. Dr. Lawrence Rogers reported that he had excised from this same patient, an epithelioma from the left lower lip four years previously. At that time, he had a small ulceration in the right cheek which Dr. Rogers curetted and cauterized with nitrate of silver.

Because of the extent of the disease involving the lower jaw, our oral surgeon,

Dr. Robert Ivy, was called into consultation, and it was decided, after preliminary irradiation, that the diseased area involving the right side of the jaw posterior to the canine tooth should be completely resected. The right external carotid was first ligated, and then the diseased portion of the jaw and the diseased soft tissue was excised by Dr. Ivy, on Oct. 25, 1929. The tissue was reported by Dr. Eugene Case as squamous-cell carcinoma. This was then followed by external radium packs, and local applications on the inside of the jaw as follows: using 250 milligrams of radium, with 150 milligrams on the right side, and 100 milligrams on the left, made up with 10 milligram units in 1 millimeter of platinum and 1 millimeter of gold, placed upon felt pads, for external applications. These external applications were made in 24-hour periods, on Oct. 14, 17, 22, 28, and 31, 1929; Nov. 15, 26, 1929, and on May 3, 1930.

Local applications were made inside the mouth on Feb. 5 and 20; May 3, and Sept. 22 and 23, 1930, giving a total irradiation inside the mouth of 666 milligrams, and externally 49,100 milligrams. The external applications were made in the form of radium packs. The patient remained well until April 3, 1934, when he died of hemorrhage from the bowel, without any evidence of recurrence of his carcinoma about the face or neck. It would seem that it was an independent condition, possibly even carcinoma of the bowel.

At times, one is tempted to destroy the disease by electrocoagulation, which destruction may include the alveolar process. Such destruction is, I believe, generally followed by a necrosis and ultimate sequestral separation, and sometimes, by a general osteomyelitis of the bone, which then requires resection, as is indicated in the following case.

Case 2. Male, aged 43 years, was referred to me by Dr. Lenox Dick, of Darby, Pa., on Nov. 23, 1918. The patient had noticed white patches on the inside of the right cheek, three years previously, at which time the dentist, while extracting some diseased teeth, accidentally bruised the inside of the cheek. From that time, it had grown progressively worse. The patient chewed tobacco until five years ago, keeping the quid on the right side. Also, he has had a pipe in his mouth most of the time. The disease was found to involve the central portion of the right cheek on the inside, and extending down to and involving the alveolar process. After preliminary x-ray treatment with low voltage x-rays, the entire diseased area was destroyed by electrocoagulation on Nov. 30, 1918. This was followed by x-ray treatment externally, and radium applications on the inside, but only to a moderate extent.

Considerable induration remained at the end of a month. This has been my experience when using partial destruction of the tumors in the cheek by electrocoagulation. The surrounding tissue becomes dense, indurated, and it is almost impossible to decide whether tumor tissue is present or not. On April 22, 1919, the disease was more extensively destroyed, and the cheek itself removed. Even at this time, I had hoped to save the lower jaw, but an osteomyelitis developed, which produced a sequestrum. This was removed together with a resection by Dr. William J. McKinley, on June 27, 1919. Further applications were made by radium and x-rays, sufficient to produce a very definite erythema. Finally, a plastic operation was performed by the late Dr. J. C. DaCosta and Dr. Charles F. Nassau, of Philadelphia. The patient has remained well to date, approximately 14 years.

At times, it seems advisable to deliberately destroy the disease, resect the bone, and combine irradiation, as is indicated in the following case.

Case 3. Male, aged 40 years, was brought to me by the late Dr. W. L. Shindle, of Sunbury, and Prof. Ernest LaPlace, of Philadelphia, on June 10, 1915, because of a carcinoma, developing during at least eight months. It involved the entire inside of his left cheek, including the upper alveolar process, and the lower jaw,

extending forward as far as the canine tooth, and posteriorly, having destroyed the entire ramus of the jaw (Fig. 3-*B*). he returned to his physician, who then cauterized the area. Since that cauterization, the tumor had grown very rapidly.

Fig. 3-*A*. Case 3. Shows the patient after resection of the lower jaw by electrocoagulation, and after separation of the slough. The patient had a carcinoma involving the entire cheek, the upper and lower alveolar process, including all of the ramus of the jaw. A resection of the jaw bone was done by Prof. LaPlace, after the preliminary irradiation and immediately after coagulation, in June, 1915.

Fig. 3-*B*. Case 3. This is a roentgenogram showing the extent of the disease, so far as it involves the bone, extending up to the floor of the antrum posteriorly, through the entire ramus, and anteriorly as far as the canine tooth. The tumor tissue had crowded the remaining molar out of its socket.

Fig. 3-*C*. Case 3. Shows the patient after a prolonged period of radium and x-ray treatment, and partial plastic operation.

Fig. 3-*D*. Case 3. Shows the wound entirely closed. The patient remained well, and continued his occupation as a travelling salesman until September, 1934, when he died of apoplexy without any local recurrence, 19 years after treatment.

When this patient was first seen by a physician, he was told to apply iodine locally, a treatment which caused so much pain that In addition to the local disease, the patient had palpable lymph nodes extending downward along the side of the neck. He had

Figs. 4-*A* and 4-*B*. Case 4. Shows a carcinoma involving the entire inside of the left cheek, with recurrence carcinoma about the angle of the mouth. This had been treated previously for some time by x-ray and there was considerable fibrous tissue present. Therefore, the entire wound was destroyed by electrocoagulation.

Fig. 4-*C*. Case 4. Shows the wound (Feb. 10, 1914) after electrocoagulation and additional irradiation, and after slough had separated, which usually requires about three to four weeks. At this time, the patient seemed to be entirely well, and was referred to Prof. Ernest LaPlace for plastic operation.

Fig. 4-*D*. Case 4. Shows the wound entirely healed, April 20, 1914. The patient remained well until July 9, 1926, or 12 years, at which time he died of angina pectoris, with no recurrence of his carcinoma.

lost ten pounds in weight. He had been an excessive smoker.

The patient was given preliminary x-ray treatment, amounting to an erythema dose, with low voltage rays, filtered through 6 mm. of aluminum, and applied externally. On the following day (June 11, 1915), under general anesthesia, in conjunction with Prof. LaPlace, I destroyed the entire diseased area of malignant disease, and Dr. LaPlace resected the lower jaw as far forward as the region of the lateral incisor tooth. When the bone was examined after removal, it was found that in the angle of the jaw, the disease had extended through the entire bone, which fractured when an attempt was made to remove it. Following this operation, radium was applied into and against the edges of the wound, for an amount that would ordinarily equal four erythema doses. The radium was highly filtered through 0.5 mm. of silver and 1 mm. of brass at that time. The patient was then given treatment with low voltage rays over the neck and the side of the face, sufficient to produce a marked erythema and atrophy. This atrophy is shown in Figure 3-*C*.

Prof. LaPlace made the first attempt to close the wound on April 22, 1916, an accomplishment which was finally completed on Sept. 16, 1916. From that time onward, the patient remained well until he died of apoplexy, in September, 1934, at which time Dr. Mark K. Gass, of Sunbury, reported that he had no evidence of carcinoma. He had been cured approximately 18 years.

When the disease has been partially treated by irradiation, and one is dealing with a recurrence in which there is associated a considerable amount of fibrous tissue, the removal by electro-thermic dissection is probably best. I find that when there is much fibrous tissue present, irradiation does not do well until it is carried to the point of producing necrosis. In all such cases, one needs the associated cooperation of both the surgeon and the pathologist, as is indicated by the following case.

Case 4. Male, aged 58 years, was referred by Dr. W. H. Dachtler, of Toledo, on Jan. 20, 1913, because of recurrent carcinoma, involving the entire inside of his left cheek, and producing an external epithelioma at the angle of the mouth, approximately 3 centimeters in diameter. The disease had begun about 12 years previously. Ten years previously, the patient had received some x-ray treatment from his local physician, but the disease did not disappear under treatment. Finally, in October, 1911, he consulted Dr. Dachtler. Temporarily, the disease seemed to have disappeared under irradiation, but it recurred, and then Dr. Dachtler referred the patient to me (Figs. 4-*A* and 4-*B*).

The patient was given preliminary irradiation to the extent of an erythema dose, with low voltage rays. Then the entire tumor area and cheek, extending back to the commissure of the jaw, was removed by electrocoagulation. This was followed by x-ray treatment externally and radium applications made on the inside of the cheek. The treatment was given by fractional doses, keeping it to the point of an erythema dose, at what to-day we would call "saturation value." The patient was treated daily until he had sufficient to cause a moderate grade of atrophy. The details are not given at this time because the technic used at that date is not important at the present time—we have improved very much since then.

Finally, in March, 1914, the wound was closed by plastic operation, performed by Dr. LaPlace, and the patient remained well for 12 years. On July 9, 1926, he died of angina pectoris, without any evidence of local recurrence.

The ideal method of treatment, and the one that not only gives the patient the least trouble, but will also lead him to come early, because it eliminates the fear incident to operations, is surface applications of radium. The gamma rays of radium, according to my clinical observation, give better results than even high voltage x-ray treatment, though, undoubtedly, good results can be obtained with high voltage x-ray treatment if the treatment is properly given. I believe that in most cases, cancer of the cheek can be treated best by local applications of gamma rays, highly filtered through 2 mm. of platinum, and from 1 to 3 mm. of rubber, which can be applied about the edges, and over the tumor area on the inside. Externally, radium packs should be applied to the extent of about 50,000 to 100,000 milligram-hours, at a distance of 4 cm., using 10 milligram units in 2 mm. of platinum, and continuing the applications during a period of three or four weeks, sufficient to produce a definite dermatitis and epithelitis, but not to the extent of producing necrosis externally. This is illustrated by the following Case 5.

Case 5. Male, aged 63 years, was referred on July 18, 1929, by Dr. William F. Weisel, of Quakertown, Pa. He had an epithelioma growing on the inside of his cheek, about the size of half a dollar, and about one centimeter in thickness. It had been first noticed by the patient six or seven years previously, following the extraction of a tooth. I presume that the tooth which had been extracted was the cause of the local irritation, and the extraction simply removed part of the cause, though the patient says that the cheek was injured at the time. He had chewed tobacco during his entire life.

The patient became concerned about the disease because it caused increasing pain. The disease had extended through the cheek (Fig. 5-*C*), and had caused, or, at least, was associated with a lymph node

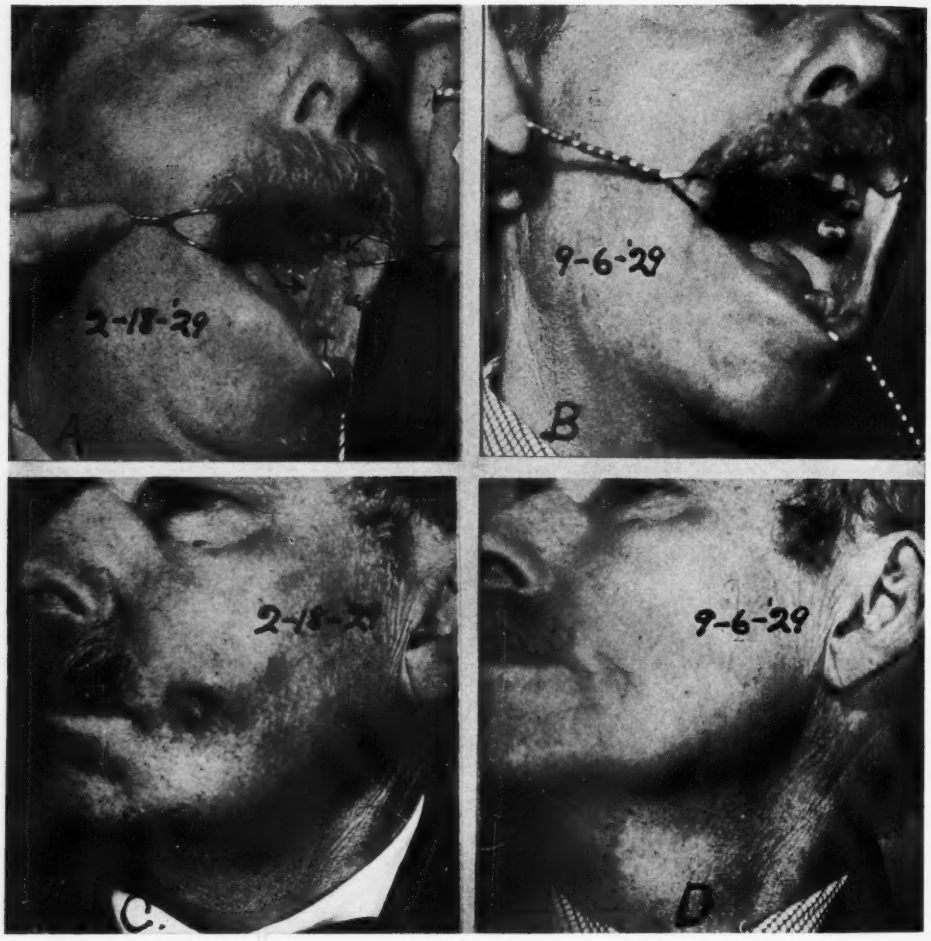

Fig. 5-*A*. Case 5. Shows a papillomatous carcinoma (Feb. 18, 1929) involving the inside of the left cheek, which grew slowly during eight years, projecting through the cheek, and was associated with metastatic lymph nodes.

Fig. 5-*B*. Case 5. Shows the tumor entirely gone, Sept. 6, 1929. The patient is well to-day, five years later.

Fig. 5-*C*. Case 5. Shows the tumor on Feb. 18, 1929, extending even through the cheek and associated with an enlarged infiltrating lymph node under the jaw.

Fig. 5-*D*. Case 5. Shows the disease entirely gone (Sept. 6, 1929), as well as the dimpling in the cheek, and enlarged lymph node. The patient is well to-day.

adherent to the jaw, extending into the left submaxillary region, as is shown in the illustration. The microscopic examination showed this to be squamous-cell carcinoma. He was treated on the inside of his mouth with 100 milligrams of radium, in 50 milligram capsules, encased in 2 mm. of platinum and 1 mm. of rubber. These were applied in three-hour periods, surrounding the edge of the growth, until he had received on the inside, a total of 2,990 milligram-hours, during a period of two months. During this same period externally, he received by means of radium packs, applied to the left side, 23,737 milligram-hours. The external packs were made up with 10 milligram units in 1 mm. of platinum and 1 mm. of gold, and applied approximately 1 centimeter apart, but particularly distributed around the pe-

riphery. The distance was four centimeters, and the applications were made for the most part during a period of three

Fig. 6-*A*. Fig. 6-*B*.

Fig. 6-*A*. Case 6. Shows the extensive tumor tissue inside the cheek (Jan. 20, 1932), of a cauliflower in character, and so extensive that there seemed to be danger of too much surface irradiation doing damage to the normal tissue. Therefore, after preliminary irradiation inside and outside of the cheek, radium needles were inserted.
Fig. 6-*B*. Case 6. Shows the tumor entirely gone, April 6, 1932, approximately six weeks after beginning treatment.

weeks, which I consider the most advantageous time for treatment. He is well to-day, five and one-half years later.

When the disease is very extensive, causing marked thickening of the cheek and locking of the jaws, so that it is practically impossible to make surface applications on the inside of the cheek, it is then advisable to insert the small quantity, dense-walled radium needles for prolonged irradiation, as is illustrated by the following case.

Case 6. Male, aged 45 years, referred by Dr. C. E. Brown, of Philadelphia, on Jan. 27, 1932, was a laborer in a storage battery factory. His smoking, which began at 18 years of age, consisted of a pipe and about a package of cigarettes every two days. He had noticed a tumor growing on the left cheek, four months previously. His jaw seemed "tight," so that he was unable to eat properly. He used salt and water as a mouthwash, but did not go to see a physician until two weeks previously. On this date, Jan. 29, 1932, the following notes were dictated.

"Patient has an epitheliomatous growth about 12 mm. in thickness, involving the entire inside of the left cheek, extending posteriorly to the commissure between the upper and lower jaws. It is triangular in shape, the anterior border being about 4 cm., and extending backward into the angle. The depth is somewhat uncertain. It seemed to have infiltrated the masseter muscle. He has several small lymph nodes about 1 cm. in diameter, 0.5 cm. in thickness, extending below the angle of the jaw. In addition to that, there are a group of small lymph nodes only a little bigger than a grain of wheat, extending down along the anterior border of the sterno-cleido-mastoid, traceable to within about 3 cm. above the clavicle.

"The patient is to have a cast made lengthwise, covering the entire left side of the neck and supraclavicular region. The left side is to be carried to a point 2 cm. above the zygoma, and the radium is to be carried up as high as the zygoma and down as far as the level of the clavicle, 200 mg. on the left, and 100 mg. on the right. The radium on the right side is to be in the form of a disc. Eight such ap-

plications are to be made within three weeks' time, in 24-hour periods. It would be advisable for him to make arrangements to-day with his employer, and to come into the hospital to-morrow morning, if there is a bed available, for Saturday and Sunday. Since the treatment cannot be started until February 3, the patient is to have, on the days preceding, four 25 per cent doses of high voltage x-rays carried through the back of his neck toward the inside of his left cheek, 2 mm. copper filter. Radium is to be applied after the preliminary x-ray treatment. Specimen of tissue is to be removed on February 5, and six 4-cm. 2-mg. radium needles are to be inserted on Friday, February 5, to remain in place five days."

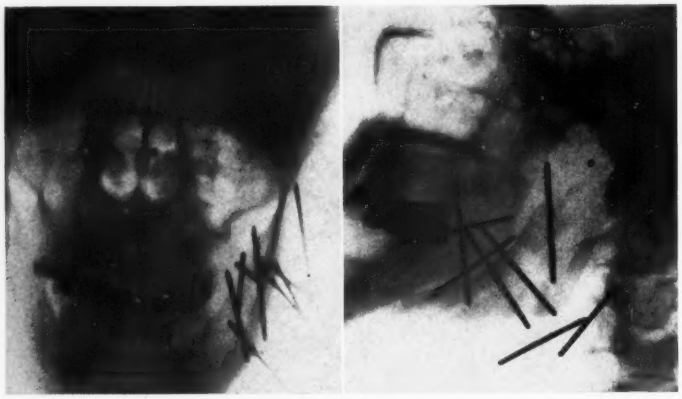

Fig. 6-*C*. Fig. 6-*D*.

Fig. 6-*C*. Case 6. Shows an anteroposterior view, giving the distribution of the radium needles.

Fig. 6-*D*. Case 6. Shows the lateral view. This suggests that the needles may have been put in at random, but they are in different layers, and are so arranged as to give a uniform distribution of the irradiation throughout the palpable tumor tissue. In addition to this, the patient received external irradiation, and is well to date.

On Feb. 5, 1932, the following notes were dictated: "Tumor on the inside of the cheek seems to have been reduced probably 20 per cent. Specimen was removed which was reported by Dr. Eugene A. Case, as squamous-cell carcinoma. Eight 2-mg. radium needles, 44 mm. in length, were inserted into the skin of the cheek, four from below upward, four from the anterior surface toward the posterior surface, and two under the left angle of the jaw."

On April 6, 1932, the following notes were dictated: "There is no visible or palpable evidence of disease inside or outside the mouth, and no break in the mucous membrane. The patient still has total alopecia in the occipital region, and back of neck. He is continuing with his job as a janitor at the Storage Battery Co." On April 9, 1932, Dr. Brown reported: "This morning, the patient whom you have been treating for a growth in the mouth, came to the hospital and showed us the result of your work. Dr. Robert Shoemaker saw him with me and believes with me that you have attained a beautiful result. His mouth is in much better condition at present than we could have hoped for, and all that remains to palpation is a small indurated area at the site of a former cauliflower, fleshy, walnut-sized growth."

The patient did not keep appointments but returned on Aug. 10, 1932, at which time the examination showed no visible or palpable disease. Infected teeth had not been removed. On Oct. 19, 1932, examination showed no visible or palpable disease, the patient being able to fully open his mouth at this time. On Jan. 4,

1933, and again on April 5, 1933, no visible or palpable disease could be seen. On June 7, 1933, and Dec. 7, 1933, the patient was well.

On Feb. 4, 1932, his blood showed the following: hemoglobin, 67 per cent; red blood cells, 4,500,000; white blood cells, 6,100; polymorphonuclears, 56; large lymphocytes, 38 per cent; monocytes, 3; basophils, 2; eosinohiles, 1. The serologic tests, both the Kolmer and Kahn, were negative. The blood sugar, taken on Feb. 4, 1932, was 126; the blood urea was N 13, and blood CO_2, 58.

A radium pack, containing 200 milligrams of radium, was applied, on February 4, to the left side of the neck at a distance of 4 cm., fastened to a wax mold, and the additional distance was made up with felt. At the same time, 100 milligrams was applied to the right side, for a period of 30 hours, making 7,200 milligram-hours. An additional radium pack was applied for 24 hours; on Feb. 10, 1932, 200 milligrams on the left side, making a total of 4,800 milligram-hours. On Feb. 5, 1932, ten 2-mg. needles were inserted into the left cheek and angle of jaw, needles being 4 cm. in length, making a total of 2,334 mg.-hours.

X-ray treatments were given through the right side of the neck over a 10 × 18 cm. field, using 200 K.V., 2 mm. of copper filtration, 25 per cent of erythema dose. A treatment of 250 r was given on the following dates: Feb. 11, 12, 18; March 3, 8, 12, 17, 22, 1932. In the left postauricular region, cross-firing on the deeper part of this growth, similar treatments were given on the following dates: Feb. 13, 16, 24, 29; March 5, 10, 15, 19, 1932.

On Nov. 21, 1934, a telephone report from the company for which the patient is working reported that he is well, and able to work every day in the power plant.

DISCUSSION

It will be seen that cancer cannot be treated by rule, but that each case must be treated according to the conditions present.

I believe that the failures in the treatment of carcinoma of the cheek are due primarily to insufficient treatment, or at least, to insufficient deep radiation therapy. For a long time, this group of cases has been giving unsatisfactory results. When the disease is caused by the irritation from tobacco or syphilis, one must realize that the damage done to the mucous membrane is not confined to one cheek. I have seen a number of cases in which the primary lesion was cured in one cheek, and the patient then developed a similar disease in the opposite cheek, which must be expected if the same primary conditions are present.

Generally speaking, I believe that prolonged and more or less continuous irradiation with gamma rays will give the best results, because these lesions are generally of the slowly growing type, therefore, relatively resistant to irradiation. That type of tumor requires a prolonged irradiation, which can be given by surface applications in the early cases, using preferably 2 mm. of platinum filtration, and giving approximately 2,000 to 3,000 milligram-hours on the inside of the cheek. Also by means of radium packs, giving from 50,000 to 100,000 milligram-hours externally at a distance of 4 centimeters.

It is my aim in the treatment of these cases to bring about an epithelitis and radiodermatitis, within a period of about two weeks, and then to retain this effect by additional dosage, during a period of about two weeks longer. In the bulky tumors, the insertion of radium needles into the tumor tissue, using 0.5 or 0.6 mm. of irridio-platinum filtration, and using needles containing 1, 2, or 3 milligrams, according to the length needed, to distribute the irradiation over the tumor area, should give the best results.

In conclusion, I would urge, however, that the most important treatment of cancer of the cheek is the elimination of the cause, and the thorough, and complete destruction of the precancerous lesions.

CASE REPORTS AND NEW DEVICES

A SIMPLE METHOD FOR ESTIMATING LOSS OF r UNITS FOLLOWING X-RAY TREATMENT[1]

By WILLIAM J. YOUNG, M.D., *and* JESSHILL LOVE, M.D., *Louisville, Kentucky*

The explanation of the difference of sensitivity of cancer cells to irradiation will prove a great aid for our attack upon them, but at present this is not satisfactorily understood. There are so many other problems that we feel a certain amount of satisfaction in presenting a chart which we have found to be of aid in computing loss of x-ray units, with exactness. With saturation technic, we have found the chart especially useful, owing to the necessity of maintaining the saturation dose over a period of three weeks. The dose over each portal of entry must be computed separately so that one may estimate the combined effective number of roentgens which shall be received by the skin to complete its 800 effective roentgens.

The chart shown in Figure 1 may be used either for finding the actual percentage of r lost over any period of time, or the remaining number of r which are still effective after the loss has been deducted. The various lines have been drawn in to mark off the several divisions.

The row of figures above the line EF indicates any dose of r units that is effective at any time during the course of treatment. The percentage of loss of x-ray energy is shown by the per cent column to the right of the line GH, while the units remaining after the loss has been deducted are determined by referring to the per cent column to the left of the line BC.

[1] Received for publication June 26, 1934.

For example, if a dose of 1,700 r has been given, and, at the end of four days, there is a loss of 20 per cent, or 340 r, the result is found on the chart by following the line opposite the "20 per cent" in the column to the right of the line GH to the figure in the column under 1,700—the dose given. (Arriving at effective percentage in a course of treatment, keep each treatment to date and finish with 800 units effective.)

To find the effective units remaining, use the "20 per cent" in the column to the left of the line BC. The answer is 1,360, as shown under 1,700—the original dose. Note that the above example is taken because it is easy to follow. Our effective dose is 800 r units, the tolerance dose to the skin.

The same procedure may be followed to find the loss and the effective r units remaining for any dose shown on the chart.

The method of demonstrating the chart in cases in which the complete portal is irradiated is as follows: Usually, each portal is given one-third or one-half a skin dose at a treatment, carried out on successive days, rotating to the different portals. The daily loss, for example, averages 5 per cent.

EXAMPLE

	r given	Total r	Effective r	r loss
June 1, Portal A	350	350	350	52
2, Portal B				
3, Portal C				
4, Portal A	350	700	648	

On June 1, 350 r delivered to Portal A would give 350 r effective on that same day. Portal A is to be irradiated three days later, there-

	B																	
0%	E	1700	1650	1600	1550	1500	1450	1400	1350	1300	1250	1200	1150	1100	1050	1000	950	900	850
5		1615	1567	1520	1472	1425	1347	1330	1282	1235	1187	1140	1092	1045	997	950	902	855	807
10		1530	1485	1440	1395	1350	1305	1260	1215	1170	1125	1080	1035	990	945	900	855	810	765
15		1445	1402	1360	1317	1275	1222	1190	1147	1105	1062	1020	977	935	892	850	807	765	722
20		1360	1320	1280	1240	1200	1160	1120	1080	1040	1000	960	920	880	840	800	760	720	680
25		1275	1237	1200	1162	1125	1087	1050	1012	975	937	900	862	825	787	750	712	675	637
30		1190	1155	1120	1085	1050	1015	980	945	910	875	840	805	770	735	700	665	630	595
35		1105	1072	1040	1007	975	942	910	877	845	802	780	747	715	682	650	617	585	552
40		1020	990	960	930	900	870	840	810	780	750	720	690	660	630	600	570	540	510
45		935	907	880	852	825	797	770	742	715	687	660	632	605	577	550	522	495	467
50		850	825	800	775	750	725	700	675	650	625	600	575	550	525	500	495	450	425
55		765	742	720	697	675	657	630	607	585	562	540	517	495	472	450	427	405	382
60		680	660	640	620	600	580	560	540	520	500	480	460	440	420	400	380	360	340
65		595	577	560	542	525	507	490	472	455	437	420	392	385	367	350	332	315	297
70		510	495	480	465	450	435	420	405	390	375	360	345	330	315	300	285	270	255
75		425	412	400	387	375	362	350	337	325	312	300	287	275	262	250	237	225	212
80		340	330	320	310	300	290	280	270	260	250	240	230	220	210	200	190	180	170
85		255	247.	240	232.	225	217.	210	202.	195	187.	180	172.	165	157.	150	142.	135	127.
90		170	165	160	155	150	145	140	135	130	125	120	115	110	105	100	95	90	85
95		85	82	80	79.	75	72.	70	67.	65	62	60	57.	55	52	50	47	45	42.
100%	C	17	16.4	16.	15.4	15	14.4	14	13.4	13.	12.4	12	11.4	11.	10.4	10	9.4	9	8.4

Fig. 1. This chart is reduced from the master chart used by us in our treatments. If it is found

fore, would incur a loss of 15 per cent, or 52 r. (Using chart, the 15 per cent in the column on the right is followed over to the figure in 52 column under 350—the three-day loss.) The 52 r are then subtracted from 700, the total dose on June 4, giving 648 r effective on June 4 Portals B and C receive the same doses, at the same intervals between treatments, and the same calculations. The method is continued until an effective dose of 800 r has been given all portals. The chart is again used to calculate the weekly loss to be given back to the patient.

CONCLUSIONS

1. The accompanying chart (Fig. 1) offers a simple means of obtaining loss, or the present amount of r units in a given portal.
2. One is thus enabled to give single or fractional doses and remain within the line of safety.
3. It is especially useful in treatments involving many portals, which necessitate complex arithmetical computations.

Brown Building

FRACTURE OF THE DORSUM SELLA[1]

REPORT OF A CASE

By M. LOWRY ALLEN, M.D., *Philadelphia*
Radiologist, Episcopal Hospital

A review of the literature fails to reveal the report of a single case of fracture of the dorsum sella. However, in this age of frequent head injuries due very frequently to the automobile, it probably occurs occasionally and no doubt has been previously seen by surgeons and roentgenologists, who have failed to report the finding. In view of the unusual nature of the injury, I feel that the following case should be reported.

H. B., white male, aged 39 years, was admitted to the Episcopal Hospital on the surgical service of Dr. Edward T. Crossan, on Nov. 5, 1933, following an automobile accident. On admission the patient was gasping for breath, bleeding from the left ear and nose and mouth, and was in extreme shock. Thirty minutes after the institution of shock therapy the patient began to react favorably, the pulse coming down to 100.

Physical Examination.—The patient was a robust, adult white male, lying quietly in bed, breathing regularly, and entirely co-operative. There was a laceration of the right parietal region which had been sutured in the Receiving Ward. The right pupil was larger than the left, and both pupils reacted well to light. There was dried blood in both nostrils, in the left ear, and also on the tongue. The heart and lungs were negative. The biceps reflex on the right was less active than on the left. The blood pressure was 76 systolic and 50 diastolic.

Roentgen Examination.—Roentgenologic examination (Fig. 1) revealed a linear fracture beginning in the left parietal bone and extending forward and downward into the squamous portion of the left temporal bone, continuing into the base, and involving the petrous portion of the left temporal bone. In addition there was a fracture of the base of the dorsum sella, with backward displacement of this structure and the attached posterior clinoid processes.

Clinical Course:—During his sojourn in the hospital the patient's general condition progressively improved. On Nov. 7, 1933, an

[1] Accepted for publication Nov. 26, 1934.

																						G
800	750	700	650	600	550	500	450	400	350	300	250	200	150	100		40	30	20	10	5.0		100%
															F							
760	712	665	617	570	522	475	427	380	332	285	237	190	142.	95		38	28.	19				95
720	675	630	585	540	495	450	405	360	315	270	225	180	135	90		36	27	18	9	4.5		90
680	637	595	552	510	467	425	382	340	297	255	212	170	127.	85		34	25.5	17				85
640	600	560	520	480	440	400	360	320	280	240	200	160	120	80		32	24	16	8	4.0		80
600	562	525	487	450	412	375	339	300	262	225	187	150	112.	75		30	22.5	15				75
560	525	490	455	420	385	350	315	280	245	210	175	140	105	70		28	21	14	7	3.5		70
520	487	455	422	390	357	325	292	260	227	195	162	130	97.	65		26	19.5	13				65
480	450	420	390	360	330	300	270	240	210	180	150	120	90	60		24	18	12	6	3.0		60
440	412	385	357	330	302	275	247	220	192	165	137	110	82.	55		22	16.5	11				55
400	375	350	325	300	275	250	225	200	175	150	125	100	75	50		20	15	10	5	2.5		50
360	337	315	292	270	247	225	202	180	157	135	112	90	67.	45		18	13.5	9				45
320	300	280	260	240	220	200	180	160	140	120	100	80	60	40		16	12	8	4	2.0		40
280	262	245	227	210	192	175	157	140	122	105	87.	70	52.	35		14	10.5	7				35
240	225	210	195	180	165	150	135	120	105	90	75	60	45	30		12	9	6	3	1.5		30
200	187	175	162	150	137	125	112.	100	87.	75	62.	50	37.	25		10	7.5	5				25
160	150	140	130	120	110	100	90	80	70	60	50	40	30	20		8	6	4	2	1.0		20
120	112.	105	97.	90	82.	75	67.	60	52.	45	37.	30	21.	15		6	4.5	3				15
80	75	70	65	60	55	50	45	40	35	30	25	20	15	10		4	3	2	1	0.5		10
40	37	35	32	30	27	25	22.	20	17.	15	12.	10	7.	5		2	1.5	1.				5
8	7.4	7.	6.4	6.	5.4	5	4.4	4	3.4	3	2.4	2	1.4	1			0		0			0%
																					H	

of assistance the authors will be glad to supply reproductions of the original chart at a nominal cost.

ophthalmological examination by Dr. Andrew Knox revealed the following: O. D., partial paralysis of the external rectus. The pupils were dilated with homatropine. The medium was clear. The outline of the nerve head was sharply defined. There was much physiological cupping noted. The veins were injected and the nerve head was quite pale. O.S., same as O.D., except for slight ptosis of the lid.

A neurologic examination, performed by Dr. Samuel Hadden on Nov. 7, 1933, showed the left palpebral fissure to be narrower than the right; also, there was definite paralysis of the right external rectus muscle. The right side of the face was not as well innervated as the left.

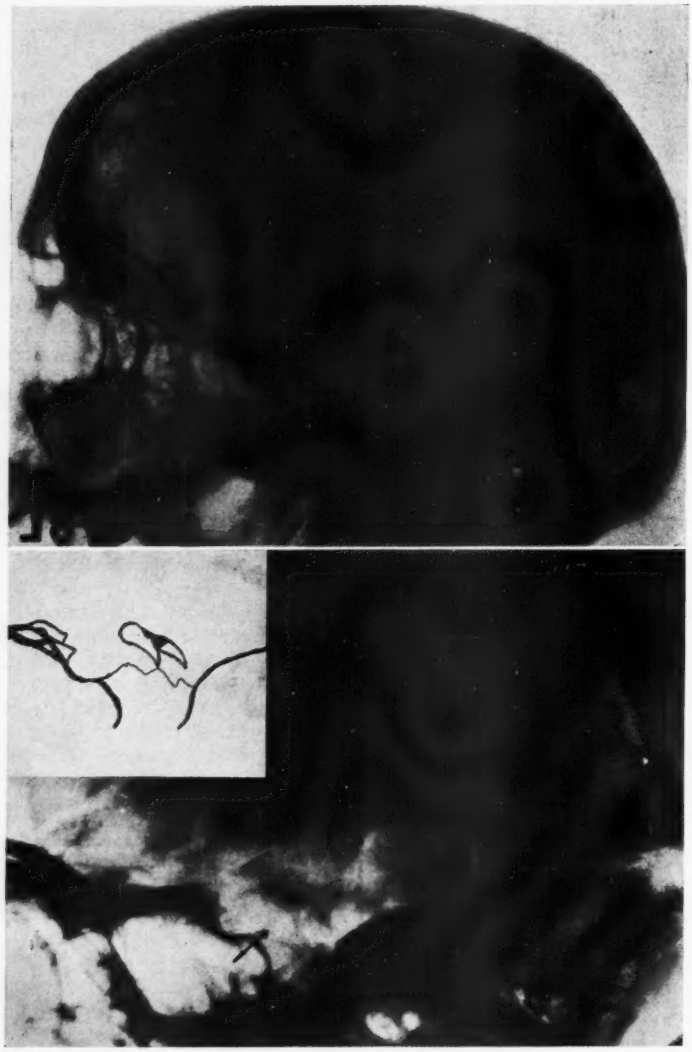

Fig. 1 (*above*). Roentgenograms made on admission to the hospital, showing linear fracture of left parietal bone and squamous portion of left temporal bone. The fracture of the dorsum sella is well shown with backward displacement of this structure.

Fig. 2 (*below*). Roentgenogram made three months after injury. The dorsum sella still shows rather marked posterior displacement.

The tendon reflexes were normal except that the right patellar reflex was a bit more active than the left. On Nov. 9, 1933, a lumbar puncture was done. The spinal fluid was under a pressure of 10 mm. of mercury, and 5 c.c. of bloody fluid were removed. Many red blood cells were present in the specimen. The blood Wassermann was negative. The blood urea and blood urea nitrogen figures were within normal limits. The blood count showed the following; R.B.C. 4,220,000; W.B.C. 11,360; Hgb. 80 per cent. Urinalysis was negative.

Fig. 3. Roentgenogram made ten months after injury. The dorsum sella is still displaced posteriorly and shows moderate rarefaction, probably representing the beginning absorption.

The patient was discharged in good condition on Nov. 23, 1933, except for a paralysis of the right external rectus muscle. On Feb. 8, 1934, the patient was seen again and found to be in good physical condition except for a residual paralysis of the right external rectus muscle. The roentgen examination (Fig. 2) at this time showed little change in the appearance of the lines of fracture, and the dorsum sella was again noted to be displaced posteriorly. The patient came in for a final check-up on Sept. 21, 1934, over 10 months after the original injury. He again manifested a complete paralysis of the right external rectus muscle, stating that in his employment as a punch-drill operator he was compelled to do his work with his right eye closed, as he had double vision when he used both eyes, particularly on looking to the right. However, he felt well in every way, being able to work steadily at his usual employment. There were no symptoms of pituitary dysfunction. Roentgenograms made at this time (Fig. 3) again show posterior displacement of the dorsum sella, with no demonstrable evidence of bony union occuring. There is some slight blurring in the outline of the fractured dorsum sella and some rarefaction present in this structure, which findings may be indicative of the beginning absorption of the fractured fragment.

Comment.—It is interesting to speculate as to the mechanism involved in the production of such a fracture. In company with Dr. O. V. Batson, Professor of Anatomy in the Post-Graduate School of Medicine of the University of Pennsylvania, the writer examined several wet and dried skulls in search for an explanation of the involved mechanism. This examination seemed to point to the following most likely mechanism: At the moment of impact by the facturing force, the contour of the cranial vault was momentarily altered to such a degree as to result in an elongation of the normal anteroposterior diameter of the skull, thus exerting marked stretching and tension on the free margin of the tentorium cerebelli and the petro-clinoid ligaments. Since these structures are attached to the dorsum sella, a sufficient sudden tautness of them would probably result in fracture and backward displacement of the dorsum sella. The injury to the patient's right sixth nerve is explained by the close proximity of this structure to the lateral aspect of the dorsum, in which location the sixth nerve lies in a definite groove on the lateral surface of the dorsum sella.

Conclusion.—A case is reported of fracture of the dorsum sella, followed by recovery.

The apparent rarity of this injury is probably explained by the fact that when it does occur, the associated cranial injuries are of sufficient severity to result in the immediate death of the patient.

COLONIC LESION

By W. H. McGUFFIN, M.D., *Calgary, Canada*

Case No. 5,634. G. A., aged 58 years, male, married, by occupation a music teacher. The patient, who was first seen by Dr. A. B. Singleton in June, 1930, complained of periodic attacks of weakness generally following a movement of the bowels, after which there would be a small quantity of blood passed. He also complained of occasional slight diarrhea, slight distention, and some borborygmus. Otherwise, his general health was good.

This condition continued and in April, 1932, a radiologic examination was conducted of the gastro-intestinal tract. Nothing of importance was discovered except at the junction of the pelvic and iliac sections of the colon where we noted a slight irregularity. There was no palpable mass and very little tenderness. After evacuation of the barium enema, air was injected and an intraluminal mass was discovered; also, multiple diverticula scattered throughout the course of the colon.

No treatment of a radical nature was instituted. The patient's health remained good

Fig. 2. Photograph of the section of bowel excised, demonstrating the papilloma. (Photograph taken by Mr. E. S. Hoare.)

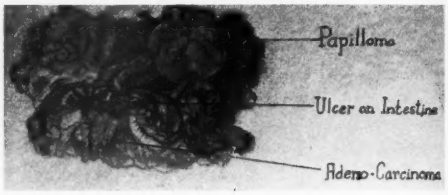

Fig. 3. Drawing, by Miss B. Forcade, of mass demonstrating the ulcer at the base of the papilloma, with malignant growth in the wall of the bowel underlying the ulcer.

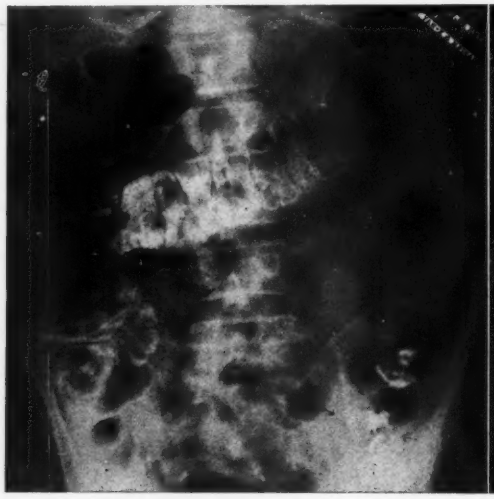

Fig. 1. The colon, following a double contrast enema—intraluminal mass junction of pelvic with iliac sections of colon; small amount of barium adherent to the mass. Examination, April, 1932.

Fig. 4. Barium enema examination of colon; deformed shadow at the junction of pelvic, with iliac colon exhibiting evidence of thickening of the walls, with encroachment upon the lumen. Examination, July, 1934.

although the periodic weak spells continued, with loss of blood after each movement.

In July, 1934, sigmoidoscopic and radiologic examinations were conducted. The sigmoidoscopic examination revealed negative findings

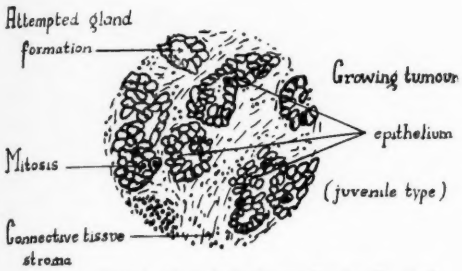

Fig. 5. Sketch of pathologic section by Dr. Lola McLatchie, demonstrating the type of cells.

except for a slight degree of injection of the walls of the upper rectal and lower sigmoid colon. The radiologic examination revealed evidence of a deformity indicative of increased bowel area involvement which lead us to the conclusion that there was, in addition to the intraluminal mass, bowel wall involvement.

Blood and urine analyses were normal. Wasserman test was negative.

Surgical intervention by Dr. W. A. Lincoln revealed a moderately large papilloma of the sigmoid colon and some thickening, with ulceration of the bowel at the base of the papillomatous mass. Four inches of bowel were resected. A rectal tube was inserted *via* the anus past the suture line and retained. A cigarette drain was introduced.

The patient has made an uneventful recovery and is now enjoying splendid health.

Pathologic Report by Dr. J. J. Ower.—Specimen from sigmoid colon: Gross: Piece of bowel six centimeters long. From the mucous membrane protrudes a pedunculated papilloma of mulberry type, roughly one and one-half centimeters in diameter, stalk being two centimeters in length.

Beside the base there is an indurated shallow ulcer two and one-half centimeters in diameter. At both edges of the base of the ulcer, there is situated a mass of firm yellow tissue, obviously malignant.

Microscopic examination of the growth at the base of the ulcer showed a localized infiltration of the intestinal wall by irregular masses of rapidly growing epithelium of juvenile type, with areas of attempted gland-formation. There were a moderate number of mitotic figures.

Pathologic diagnosis revealed an adenocarcinoma of the ulcer at the base of the benign pedunculated papilloma.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

THE RADIOLOGIST AS PHYSICIAN[1]

At the recent meeting of the British Medical Association at Bournemouth, Dr. Le Fleming, speaking from the general practitioner's point of view on the value of radiology in diagnosis and treatment, advocated a more close and personal contact between the radiologist and the family doctor. He said that the present relationship fell somewhere midway between the ideal of the medical consultation and the more remote pathologic report. He added the ominous opinion that the trend of affairs was, on the whole, away from that personal contact which he advocated.

If Dr. Le Fleming is correct in this view—and I am afraid there is truth in what he says—then I venture to say it is a bad thing for radiology and for medicine in general.

Laboratory Diagnosis in Radiology.—The term "laboratory diagnosis" may be applied to any method which does not call for personal examination of patients. There can be no doubt that a large part of radiodiagnosis as carried out at hospitals comes within this definition. There is no essential difference between the radiologic report on a film and the pathologic report on a microscopic slide.

This tendency toward laboratory diagnosis in x-ray work was not at first evident. In the early days of x-rays the man unquestionably dominated the machine. Many of the pioneers, such as Williams, of Boston, were distinguished physicians before they devoted themselves to the new method, and, the fact that radiography of moving organs was then impossible made screen work by the physician essential for the chest and alimentary tract. X-rays were at first largely aids to direct clinical examination, and were employed by persons who continued to rely to a great extent on older and well-tried clinical methods.

With the increasing power and complexity of apparatus there arose a new type of radiologist, who was often attracted to the specialty solely because he had a liking for mechanics. The machine began to dominate the man. The first object became, in a literal sense, the production of "more, bigger, and better" radiographs. The 12 × 10 in. film gave way to the 15 × 12, and this to still larger sizes. Speed and definition increased at the same time. The second object was to interpret the films. The "direct evidence" school, as opposed to the continental school which believed in diagnosis by symptom complexes, no doubt made radiodiagnosis more nearly approach an exact science; but, at the same time, tended to divorce it from clinical medicine. The slogan "show it to me on a plate" served a useful purpose, so long as new findings were being continually demonstrated, interpreted, and classified. But inevitably there came a slowing-down of this process. The work of exploring and charting the mountains, rivers, and oceans of this new country came to an end, and there now remain only remote streams and valleys where the explorer may still find something new. To leave aside metaphor: 99 out of every 100 films seen in an average day's work in the radiodiagnostic department of a large hospital can be interpreted according to a well-established routine. I have no hesitation in saying that an intelligent person occupying the post usually referred to as "sister x-rays" could, after a few years' experience, almost replace the radiologist so far as the actual reading of films is concerned. The illness of my junior once compelled me to accept a suggestion of the sister-in-charge that, to save time, she should write reports in advance, leaving it for me to read and sign them only. It was a humbling and a chastening experience which I can recommend to anyone who may suspect himself of spiritual pride. I do not, of course, mean to suggest that an x-ray department could be run in this fashion indefinitely; but if we think of an out-patients' department in charge of a competent physician, it is impossible to imagine its being carried on with any degree of efficiency even for a single day without him.

An All-round View of the Patient.—Con-

[1] Presidential address to the section of radiology of the Royal Society of Medicine on Oct. 19, 1934. Reprinted by permission of the author.

LLOYD BRYAN, M.D., of San Francisco, President of the Radiological Society of North America.

siderations such as the above tend to show that the radiologist must beware lest he become a mere interpreter of film images, no matter how skillful. That he should see all the patients in a crowded hospital department is a manifest impossibility, but he should personally examine chest patients and alimentary-tract cases, and so far as the exigencies of a busy life permit, attend operations and visit the post-mortem room. When he cannot do this, he should adopt some method of being kept informed as to the results.

It is to be hoped that the time will never come, although there are some who visualize it, when there will be no private practice in radiodiagnosis. For it is in private practice that the radiologist has the greatest opportunity to let the physician which is in him—or which, at any rate, *ought* to be in him—live for a time on equal terms with the specialist. Let him carefully take the histories of all his patients, and he will not seldom hear things of importance which have not been elicited by anyone else. For it is a fact that, apart from neurasthenics who have their whole case written out on paper, patients will rarely give precisely the same history to two different men.

The history may suggest that a patient who has been sent for examination of the alimentary tract is in reality suffering from some trouble in the chest—or *vice versa*. It is, of course, the duty of the radiologist to carry out the examination requested; as to what he should do in addition, he must use judgment and tact. I recall upon an occasion many years ago being asked to examine the lungs of a patient for tuberculosis, as he was very breathless. It was at once evident on screen examination that the trouble was cardiac. I reported to this effect, and was told by the doctor concerned that "he wanted a 'picture' of the patient's lungs, and would I please mind my own business as regards his heart." Such an attitude is now fortunately rare, but not wholly unknown. Its absurdity is evident when we consider that it is equivalent to sending a patient to a consulting physician with a request to palpate the abdomen, but on no account to put a stethescope on the chest.

The arts of inspection, percussion, and palpation should never be lost. Inspection may show a hitherto unnoted skin nodule, a patch of pigment, a forgotten operation scar, an area of pulsation, or some other valuable guide as to what should be particularly looked for in the radiographic examination. The necessity of palpation in conjunction with the opaque meal or enema hardly needs emphasizing, but the finding of an enlarged spleen may give the clue to an unexplained hematemesis or melena.

The practitioner who resents the radiologist taking an all-round view of his case, will eventually drift to someone who gives him exactly the kind of radiologic service he deserves. If he alone were concerned, that would be of little consequence. But it is hard on his patients, and therefore the psychology of the matter is worth considering. I think that subconsciously his mental processes are something like this: "Except in the reading of x-ray films this man is no more competent than I am to deal with this case, and his doing some of the things which I have already done, or could have done lets me down in the eyes of my patient." Note that the same man does not resent the consulting physician palpating a case that he himself has already palpated, or feel humiliated if something is discovered which he has missed. This brings us to a very important point. If the diagnostic radiologist wishes to hold his own in the future—if he wishes to remain a free-swimming organism, and not settle down to a sessile stage in the confines of a laboratory—he must be as highly qualified as the consulting physician. As a young man he should seek house appointments where extremely valuable general experience can be found, and should take a higher medical qualification either before or after, but preferably before, taking one of the special radiologic diplomas. I have noted of late a tendency to regard a higher medical qualification as essential for certain radiologic appointments. It is an excellent innovation and should be encouraged by radiologists as a body.

Then there is the question of all-round knowledge of a special subject. For instance, a new form of comparative pathology is called for. It is not enough for a man to know the radiographic appearance of certain diseases: he should be equally familiar with these diseases in their clinical and pathologic aspects. This ideal has been lived up to by some, and the appointment of a radiologist as Hunterian professor at the Royal College of Surgeons is a good omen for the future.

An All-round View of Medicine.—There is yet another reason why it is of extreme importance that radiologists interested in diagnosis should keep in touch with medicine as a whole.

Diagnostic radiology to-day is in much the same position as surgery—it is unlikely to make any great advance unless helped by some extraneous discovery. In the sixties of the last century surgeons had conceived, and in many cases attempted, most modern operations; but sepsis continued to defeat them. Then came Pasteur, a chemist, with his work on fermentation; and Lister, a practising surgeon. Such a combination is essential. Had Lister confined himself to acquiring technical skill as a surgeon, he might never have heard of Pasteur's work, much less applied it, and so made possible the surgery of to-day. Similarly we need radiologists who are always alert to apply discoveries in other fields.

The gall-bladder demonstrations which we are now able to carry out are not the result of direct investigation. The study of the concentration of certain compounds in the gall bladder was begun as a biochemical research. But it occurred to a radiologist who knew of these experiments that the substitution of bromine or iodine for chlorine in the formula might result in the concentration in the gall bladder of a substance opaque to x-rays. Cholecystography and intravenous pyelography are the only advances in radiodiagnosis which were not foreseen by one or other of the early workers. In a book published by Williams, of Boston, in, I think, 1899, you will find practically everything else referred to, notably instantaneous radiography and opaque meal examinations. At the moment nothing appears on the horizon except elaboration of existing processes. Let us pray for a biochemist to discover something of value to us, and for a radiological Lister capable of seizing upon the discovery to lighten our darkness.

The Specialty of Method: Its Limitations and Dangers.—Now, if it is important for those of us who practise diagnosis to be physicians before we are radiologists, it is, if that be possible, a matter of even greater moment for those who profess and call themselves therapists. To paraphase slightly a well-known jibe, the time has gone by for complacently pouring rays of which we know little into a body of which we know nothing. So far, radiotherapists have shared with surgeons the unique distinction of being specialists in a method. They have reached their present none too secure position because therapeutic apparatus has been continually advancing in power, and because technic has been in a fluid state. But there are now signs of stabilization, and the modern dosimeter has made it safe for lay assistants to apply routine prescriptions. Radiotherapeutists who are inclined to be complacent, should study the history of electrotherapeutics in this country. A decade ago it reached the stage of standardization; from that time onward it has passed more and more into lay hands. The medically qualified man who confined himself to carrying out the actual technic of electrotherapy has been crowded out; with few exceptions, only those who have established themselves as physicians interested in a class of diseases known to be benefited by electrotherapy have survived. I fear for radiotherapeutists a similar extinction unless, like the wise men just referred to, they take steps to consolidate their position.

There are three possible forms of specialization in medicine.

(1) There is the specialty of method, as exemplified by the surgeons; also to some extent by the vaccine therapists, electrotherapeutists, radiotherapeutists, and one might perhaps add the osteopaths.

(2) There are the regional specialties—the eye, the ear and throat, urinary system, etc. The ophthalmologist, the laryngologist, the urologist, the gynecologist are concerned with a particular set of organs, and consider themselves free to use any method of treatment which seems to them good. Many are fellows both of the College of Physicians and the College of Surgeons; the limitations which custom imposes upon them are topographical, not therapeutic.

(3) There are specialists connected neither with therapeutic methods nor with particular regions of the body, but with diseases as such. Experts in tuberculosis, in rheumatism, and in tropical diseases are examples.

It is with the first and third categories that radiologists should concern themselves. There is so far no instance of a "specialty of method" pure and simple having survived. If surgery be instanced, it can at once be pointed out that it survives because it invades the third group—namely, that of specialties in particular diseases. That some surgeons fully realize this is evident from their publicly expressed opinions. All radiotherapeutists should read the address given by Mr. Geoffrey Keynes to the Royal Medical Society of Edinburgh in February last, on the Future of Surgery. (Lancet, 1934, **1**, 1043). Speaking of cancer he said:

"So large a proportion of surgical activity is taken up with cancer that its removal from the sphere of surgery would cause an enormous hole in the surgeon's day. Moreover, it appears to me that if this is ever to happen at all it will happen suddenly. . . . The cancer problem. . . is partly a biochemical one, and the process of

experimental cancer production is so nearly perfected that the successful reversal of the process may not be so far distant as we are often inclined to suppose. Surgery can often deal successfully with the primary cancerous growth when it is accessible. *It is by the inaccessible parts of the disseminated disease that we are so constantly defeated.* [Italics mine.] Cancer disseminates by the circulation, whether it be by blood vessels or lymphatics, and perhaps it is by the same route that it will ultimately be attacked, particularly if a biochemical cause leads to the discovery of a biochemical cure."

Such is Mr. Keynes's vision of the future, and I think few will disagree with him. Note, however, the consolation which he proceeds to offer to his colleagues. He says: "Those surgeons who are sufficiently adaptable may be able to add the biochemical method to their repertory, for after all it will still be the surgeons who will make the diagnosis and have much of the responsibility for the treatment of the patients." A little later in his address, however, he seems to have had doubts about the matter, for he says, speaking of the advance of radiotherapeutics: "This process of encroachment will not stop, and perhaps in the end it will be the radiologists and not the surgeons who will receive the rudest shock from the cry that 'cancer is conquered.' "

Now, while it may in some cases be inevitable, it is on the whole, a bad thing for any body of medical men to be wholly dependent upon a single method of treatment. Human nature being what it is, such a state of affairs may conceivably clog the wheels of progress. I suggest to the younger radiologists who are interested in therapy that they should concentrate on those diseases in which radiotherapy constitutes the chief, or at any rate a very important part of their treatment. Cancer of the breast is an excellent example. I think unbiased observers must admit that in this condition radiation is now of an importance at least equal to that of surgery. It should therefore be the aim of radiologists to become the leading authorities on the disease. They will not attain this position by concentrating on the precise means by which to apply x-rays or the radium "bomb," any more than surgeons reached their standing solely by skill in the performance of the radical operation. In the past, surgical writings have been the source of practically all that is known of breast cancer—its etiology, pathology, diagnosis, and treatment. Unless and until the radiologist knows as much about every aspect of breast cancer as does the surgeon—apart, of course, from operative technic—he must not expect the medical and lay public to recognize him as the principal person to have charge of a case.

Radiologists have at the moment an opportunity to study breast cancer from a new aspect. The deadliness of this disease lies in its metastases. When once these are clinically evident, though much may still be done, the patient's life is ultimately forfeit. If, however, we could get warning of an outbreak at the pre-clinical stage, we might perhaps do something useful. It is claimed by certain biochemists that the vanadic acid sedimentation test is capable of giving such a warning, by showing the blood picture to be moving in an abnormal direction. How long the warning is ahead of the active mischief we do not yet know, nor whether the seeming danger signal is always justified.

Confining oneself to facts which appear well authenticated one can say that most breast cases show an abnormal blood at the time of diagnosis; that with the removal of the primary growth whether by operation or radiation the reaction becomes normal in some cases; and remains or again becomes abnormal in others; and that it can in many instances be brought back again to normal by widefield x-ray treatment of low intensity. The effect is constitutional and must be sharply distinguished from intensive methods designed to produce a local reaction. We do not know for certain whether metastases can develop in the face of a blood normal to the vanadic acid test, but the investigation, linking up as it does radiology with biochemistry, would seem to be worth pursuing.

Training of the Radiotherapist.—It is obvious that our colleagues, and more especially those who are in general practice, will not accept us as authorities on certain diseases—even when radiotherapy is admitted to be of prime importance in their treatment—unless by training and qualification we can inspire confidence. At least three years spent in house appointments would seem desirable, and although it may perhaps be a counsel of perfection, a year in general practice would be of the utmost value. At the end of this time, a higher medical qualification should be aimed at.

With regard to the more technical side of radiologic education I am in agreement with Dr. R. S. Paterson who, in his presidential address last year, expressed a doubt as to whether the enthusiasm for physics was not being carried a little too far. It is not that any of us could know too much physics, but when time is limited, as it must be, one has to consider its value in relation to other studies. For instance, there is biochemistry, which I feel will become of increasing importance to the radiotherapeutist. And there is the general pathology and clinical aspect of diseases amenable to x-ray treatment. Concerning a physical problem we can always consult a physicist; but faced with a patient we must depend on ourselves.

Dr. Paterson, in his address referred to the matter of a higher diploma in radiology—which he said would have to be seriously taken up in the future. It is already the future by 12 months, and, in my opinion, it is time that some preliminary steps were taken to realize this ideal. The first of these steps, which must be taken by radiologists themselves, might perhaps be the provision of some form of recognition for those who have done original work of value to radiology.

In conclusion, if anyone says that the road I have outlined is too hard a one for the neophyte to tread, I would remind him of the old proverb which says that, "he who wills the end must also will the means"; or, if a classical quotation be preferred, *per ardua ad astra*.

F. HERNAMAN-JOHNSON, M.D.
London, England

Hon. Radiologist to the French Hospital, London; Physician in Charge of Radiotherapeutics, Croydon General Hospital.

ANNOUNCEMENTS

AMERICAN BOARD OF RADIOLOGY

The American Board of Radiology has decided to hold a meeting on the West Coast about the middle of May, 1935, at which time candidates will be examined for certificates. The Board has chosen to do this because of the fact that there are a number of applications on file from that section of the country, and it was felt that a meeting should be held at a place where it would be convenient for such applicants to appear before the Board. Anyone who is desirous of appearing before the Board at that time should have his application completed and on file in the Secretary's office not later than March 1, 1935.

There will also be a meeting of the Board in Atlantic City, June 8, 9, and 10, 1935, at the time of the session of the American Medical Association. Anyone wishing to appear before the Board at that time should have his application in the Secretary's office not later than April 1, 1935.

The minimum requirements for eligibility to make application for a certificate are:

1. Membership in at least one of the national radiologic societies, the American Medical Association, or the Canadian Medical Association.

2. At least three years' experience in radiology during which time not less than 75 per cent of the applicant's time has been devoted to radiology.

3. That the applicant does not hold or has not applied for a certificate from a specialty board, and that he does not list himself in the American Medical Directory or elsewhere as a specialist in some branch of medicine other than radiology.

4. That at least 75 per cent of the applicant's time is being devoted to radiology.

B. R. KIRKLIN, M.D.
Secretary-Treasurer of the American Board of Radiology

SURGEONS TO MEET IN JACKSONVILLE, FLORIDA

The Southeastern Surgical Congress, through its secretary, B. T. Beasley, M.D., announces the sixth annual assembly of the Congress which will be held in Jacksonville, Florida, March 11, 12, and 13, 1935. The Congress has met previously in Atlanta, Birmingham, and Nashville.

The States composing the Congress are Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. A record attendance is anticipated at the Jacksonville meeting. Since March is the most desirable month to visit the land of flowers many surgeons will no doubt combine business and pleasure and attend during this season of the year.

Some of the most distinguished surgeons in the country, representing the different surgical specialties, have been invited to appear on the program. A partial list of those who have already accepted places is as follows: Walter C. Alvarez, M.D., Perry Bromberg, M.D., Hugh Cabot, M.D., Willis C. Campbell, M.D., George W. Crile, M.D., John F. Erdmann, M.D., Paul Flothow, M.D., Ralph Green, M.D. Arthur Hertzler, M.D., C. Jeff Miller, M.D., Alton Ochsner, M.D., J. C. Patterson, M.D., J. Knox Simpson, M.D., J. W. Snyder, M.D., and W. A. Weldon, M.D. More than twenty others will be listed when the program is completed. Look for the completed program which will be mailed about Feb. 15, 1935.

For information address B. T. Beasley, M.D., Secretary-Treasurer, 1019 Doctors Building, Atlanta, Georgia.

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BONE DISEASES (DIAGNOSIS)

Osteodystrophia Fibrosa Unilateralis. Karl Goldhamer. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1934, **49**, 456–481.

This is a detailed case report of osteitis fibrosa cystica (Recklinghausen) in a girl nine years of age, observed for four and a half years and verified histologically. Unusual observations: (1) Diffuse fibrocystic disease involving the *left* ischial bone and the *left* upper and lower extremities; lesions are found to diminish in extent from proximal to distal and from lateral to medial in the left hand and foot; (2) circumscribed fibrous changes are found in the *left* cranial vault, diffuse fibrous changes in the *left* mandible and the *left* occipital bone; (3) cystic changes are observed in the *left* pelvis, femur, tibia, and fibula; (4) osteosclerotic changes have been demonstrated in the *left* half of the base of the skull and the *left* facial skull; (5) pubertas præcox. There follows a discussion of differential diagnostic possibilities.

H. A. JARRE, M.D.

Osteosarcoma in the Course of Paget's Disease of Bones. J. Haguenau, L. Gally, and P. Daum. Bull. et Mém. Soc. Med. des Hôp. de Paris, June 4, 1934, **50**, 786–793. (Reprinted by permission from British Med. Jour., Oct. 6, 1934, Epitome of Current Medical Literature.)

Paget observed the frequent occurrence of sarcoma in the disease bearing his name, and Leri noted that this malady predisposes to gout and cancer, especially osseous cancer: several cases are recorded in the literature.

The authors present details of a case of Paget's disease in which an osteosarcoma of the right knee with metatases in the cervical vertebral region developed. Death supervened in six months after the first appearance of pains in the knee. In most cases these tumors appear after the age of 50, and much more frequently in males, and they invariably develop on bones presenting, at least radiologically, the characteristics of Paget's disease, and never on normal ones.

Histologically, they most frequently resemble ordinary sarcoma; in one case, however, myeloplaxic tumors occurred, and in another von Albertini noted that the marrow of the affected bones was converted into a tissue of fusiform cells, sarcomatous in appearance, and he suggests the possible formation in "pagetic" bones of a presarcomatous tissue capable of true sarcomatous degeneration. The present authors believe that this complication is too infrequent to permit of this hypothesis, and consider that these cases are analogous to those neoplastic degenerations following chronic irritation. The prognosis of these sarcomas is rapidly fatal and no treatment is of any avail.

A Contribution to Etiology and Roentgen Diagnosis of Bone Sarcoma, with Remarks Concerning "Osteo-arthropathie Hypertrophiante Pneumique." J. Palugyay. Fortschr. a. d. Geb. d. Röntgenstrahlen, August, 1934, **50**, 107–120.

A case is reported wherein, following trauma, symptoms of osteomyelitis of the right femur developed. During the course of several months the bone lesion was recognized as an infected osteochondrosarcoma. Ex-articulation at the hip was followed by well-being for over one year, when mediastinal lymphoglandular metastases developed, producing a stenosis of the right lower bronchus with consecutive atelectasis of the right lower lobe. Simultaneously, the typical picture of "osteo-arthropathie hypertrophiante pneumique" developed.

There follows a discussion concerning the relationship of trauma to the development of a bony malignant neoplasm. On the basis of the analysis of clinical, roentgenologic, and histologic findings in this case it is assumed that the trauma led to sarcomatous degeneration of an occult, quiescent chondroma, followed by autogenous infection, with osteitis. The differential diagnosis between benign osteitis and a malignant bone tumor is discussed. Finally, the symptomatology of the osteo-arthropathy and its etiology are mentioned.

This osteo-arthropathy was described first by Pierre-Marie and is known under the names "osteo-arthropathie hypertrophiante pneumique, toxic proliferating periostitis, arthropathia hypertrophicans toxica, akropachie, toxigeneous ossifying osteoperiostitis." The etiology of this rare symptom-complex is traced to chronic infectious processes, especially putrid pulmonary infections, chronic infectious cardiovascular disease, chronic stimulation of bone by toxins, including chronic passive congestion. Pulmonary tuberculosis, bronchiectasis, lymphogranulomatosis, chronic diseases of the liver and kidneys, chronic lymphadenitis, dysentery, and various other types of chronic infectious diseases are reported to elicit the bony manifestations which have to be regarded as chronic inflammatory changes, leading partly to atrophy and rarefaction, partly to hypertrophic osteitis. A generalized osteophytosis has been observed and also multiple toxic arthritis. The terminal phalanges of the hands show clubbing. These bony changes may not produce any subjective complaints in very mild cases, while in more advanced instances there is pain on pressure on the bones and intermittent spontaneous bone pains, occurring particularly at night, of one to several hours' duration. In the most advanced cases, hands and feet become tremendously enlarged so as to resemble giant paws, with diffuse swelling of forearms and legs. In such an instance the primary underlying disease may be entirely obscured by the manifestations in the extremities. Symptoms always are quite symmetrical in distribution, involving the diaphyses of the long bones, particularly radius, ulna, tibia, fibula, femur, metacarpals, metatarsals, while participation of the humeri has been seen only rarely. Mandible and spine hardly ever are involved.

When recurrences develop one may observe irregular, lumpy osteophyte formation. Destructive bony

changes are seen in the epiphyses and apophyses, chiefly manifest as a queer rarefaction of the spongiosa. Whenever the disease is well developed, acromegaly will have to be considered for differential diagnosis. Then it is to be remembered that, in the case of the osteo-arthropathy the clubbing of the terminal phalanges is present, beside the enlargement of the hands. Furthermore, one should observe enlargement of the bones, simulating swelling of the articulations. The skull in all such instances is negative. In acromegaly, on the other hand, one will find a practically normal configuration of hands and feet in spite of the enlargement; the latter terminates at the joints; Arnold, Erb, and von Recklinghausen, however, assume that mixed types occur. Roentgenologically, syphilis of the skeletal system may be considered for differential diagnosis. Comparative views of symmetrical portions of the skeleton, multiple localization, and etiologic primary disease will lead to a differential diagnosis.

H. A. JARRE, M.D.

CANCER (DIAGNOSIS)

The Diagnosis and Treatment of Primary Carcinoma of the Bronchus or Lung. Evarts A. Graham. Am. Jour. Roentgenol. and Rad. Ther., February, 1934, **31,** 145.

It is now known that primary carcinoma of bronchus or lung constitutes at least 5 to 10 per cent of all carcinomas. Practically all, if, indeed, not all, of them arise in a bronchus, the usual location being one of the primary divisions of the main bronchi. The undifferentiated basal cell is thought by some to be the source of the several cellular types of carcinoma arising in this location. While ulceration usually occurs rather early, with broncho-stenosis or bronchial occlusion and atelectasis, one may occasionally encounter a case in which the tumor grows diffusely about the bronchus and is slow to produce ulceration or bronchial obstruction. Symptoms may occur first from metastases, particularly if the latter are located in the long bones or brain. The duration of the disease is quite variable, the average period between onset of symptoms and death being less than two years.

Of 26 proven cases with necropsy studies, 17 complained on admission to the hospital of cough, 11 of chest pain or discomfort, 11 of dyspnea, and 10 of expectoration, while at the same stage only six noted weakness and nine weight loss. While bronchoscopy, with removal of a bit of tissue, is usually necessary to establish an absolute diagnosis, the author warns against the danger of making a definite diagnosis of malignancy by an inexperienced pathologist in cases in which there is only metaplasia or hyperplasia, as may occur in bronchiectasis. Occasionally lipiodol is useful in showing the tumor to be extrabronchial, particularly in the presence of atelectasis.

As concerns therapy, the writer doubts the adequacy of bronchoscopic removal and/or deep radiotherapy. He briefly reports one case of a physician with a primary carcinoma of the squamous-cell type arising from the left main stem bronchus from whom he successfully removed the entire left lung at one stage. Six months after operation the patient had gained 16 pounds in weight, was gaining in strength, and was aware of no more dyspnea on exertion than a normal man of his age.

J. E. HABBE, M.D.

CANCER (THERAPY)

The Influence of Ultra-short Electrical Waves on Malignant Tumors. E. Hasché and W. A. Collier. Strahlentherapie, 1934, **51,** 309.

The authors studied the effect of electric waves of 3.5 meters length on transplanted carcinoma (Ehrlich strain) in mice. They found that neither total body, local treatment, nor exposure *in vitro* had any effect on the malignant neoplasm.

ERNST A. POHLE, M.D., Ph.D.

A Preliminary Report Concerning our Three Years' Experience in Cancer Therapy with Extremely Hard Roentgen Rays. E. v. Schubert. Strahlentherapie, 1934, **51,** 271.

The author relates his experience with super-high voltage in the treatment of advanced gynecologic carcinomas during the last three years. He used about 600 K.V., 1–2 ma., 94 cm. F.S.D., 3 mm. Cu + 3 mm. Al; the output was 2–4 r per minute. If 20 single doses of 200 r were applied on successive days, no untoward skin reactions were observed. Later he applied as much as 4 × 500 r in 2 days; this could be increased to 4 × 750 r. Four to six weeks after roentgen therapy radium may be applied in doses of about 3,000 to 4,000 milligram-hours. Since only far advanced cases were used, no definite evaluation of the treatment for early carcinoma can be given. The results were, however, encouraging enough to warrant further effort and expense toward the development of super-high voltage therapy.

ERNST A. POHLE, M.D., Ph.D.

Stubborn Skin Cancer and its Cure. A. Hintze. Strahlentherapie, 1934, **51,** 237.

The author presents a critical analysis of 71 cases of skin carcinoma which did not remain cured following treatment by either operation or irradiation. His statistics show that 39 cases were operated on and 32 treated by x-rays or radium. Sixty-two cases had cancer of the face (16 multiple lesions). In four patients the lesions were on the body or on the extremities. Three cases had a lupus carcinoma and one a roentgen carcinoma. Four patients primarily operated on and operated on repeatedly after that were not cured. Thirty-five patients were primarily operated on and then irradiated; 19 of these were cured by roentgen therapy. Seventeen patients had been irradiated in some other clinic first and developed a recurrence; being mostly re-treated by irradiation, four of these were cured. Fifteen cases treated primarily in the author's clinic developed multiple lesions in nine cases, while in six patients there was a recurrence of non-healing of the original lesion. Eight out of the group with

multiple lesions and three out of the group with recurring lesions are cured now by irradiation. Of the three cases with recurrences which did not heal following repeated irradiation, two were treated with multiple small doses and one with medium large doses. None of these patients had been treated with massive doses when first seen. The author comes to the conclusion, therefore, that, except for patients with multiple lesions, the non-healing of the skin carcinoma is in all probability due to insufficient treatment when the patient is seen for the first time.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Therapy through Small Fields in Deep-seated Tumors. A. Kukowka. Strahlentherapie, 1934, **51,** 312.

In order to obtain a high depth dose with as little injury to the skin as possible the author has developed a "small field technic." He uses as many as ten or more 4 sq. cm. areas. Each field receives 600 r (0.5 Cu, 180–200 K.V., 3–4 ma., 23–50 cm. F.H.A.). Using 10 fields with this technic, the tumor receives approximately 3,000 r, one field being exposed each day. Although it is too early for a statistical evaluation of this method, the author has seen encouraging results and also believes that it is possible to bring as much as from 4,000 to 8,000 r into the tumor.

ERNST A. POHLE, M.D., Ph.D.

The Incidence of Vaginal Fistulæ in Patients with Carcinoma of the Cervix. Frank R. Smith. Am. Jour. Cancer, September, 1934, **22,** 52–58.

This paper is an attempt to answer the question of the frequency of vaginal fistulæ following irradiation therapy for carcinoma of the cervix. A comparison made with a group of untreated patients showed that vaginal fistula incidence is primarily a manifestation of advancement of the disease, the incidence being twice as high in the untreated patients. In irradiated patients the incidence is increased by interstitial radon irradiation, lack of filtration, re-treatments, infection, strictural type of lesion, and hysterectomy before irradiation.

W. A. SODEMAN, M.D.

Chemotherapy as a Supplementary Treatment in Radiation Therapy of Malignant Disease. F. Nahmmacher. Strahlentherapie, 1934, **51,** 305.

The author believes that chemotherapy can be used as a valuable adjunct to radiation therapy of carcinoma. He recommends a preparation containing a combination of lithium, magnesium, and iodine, compounded in such a manner as to avoid irritation of the intestinal tract. A hypothetical explanation of the effect of each element in the medicament on the cancer patient is offered. The author also emphasizes that his preparation is non-toxic and does not produce any of the symptoms of iodism.

ERNST A. POHLE, M.D., Ph.D.

CATHODE RAY

Possibilities of High Speed Cathode Rays in Therapy. A. Brasch and F. Lange. Strahlentherapie, 1934, **51,** 119.

The authors constructed a cathode tube which can be operated at 2,000,000 volts. They consider as an advantage of cathode rays the well-defined length of path, the fact that more energy is released in the depth than on the surface, their enormous biologic effect, and the possibility of "aiming" the beam by means of magnets. The length of path in tissue for cathode rays produced at 2,000,000 volts is about one centimeter. The maximum effect seems to be at about 2 mm. depth, a fact which has been proved experimentally by placing over the skin a filter of a thickness equivalent to the length of path. One thousand erythema doses were applied without causing any effect on the skin. Photographs are shown with the article demonstrating the destructive effect of cathode rays on metal and insulating material. The technic of application is described; it is possible to use a small "injection" needle with a window which can be introduced into a deep-seated malignancy. This permits irradiation at the site of the lesion without exposing the tissue between the skin and the tumor.

ERNST A. POHLE, M.D., Ph.D.

Radiobiological Experiments Undertaken as a Basis for the Use of High Speed Cathode Rays in Therapy. R. Glocker, G. A. Kugler, and H. Langendorff. Strahlentherapie, 1934, **51,** 129.

The authors experimented with the tube built by Brasch and Lange (see "Strahlentherapie," 1934, **51,** 119) on *Drosophila* eggs. They determined the distribution of the cathode-ray energy (1.6 million volts) in the depth of a phantom. They found that at a certain depth the dose was about one and a half times as large as the surface dose. This is considered as one of the greatest advantages of cathode-ray therapy.

ERNST A. POHLE, M.D., Ph.D.

Studies of the Biologic Effect of Cathode Rays. W. Gentner and F. Schmidt-La Baume. Strahlentherapie, 1934, **51,** 139.

The skin of rabbits was exposed to a Lenard tube (212 K.V., 1 ma.) at 9.45 cm. distance. At the same time, exposures were given with Grenz rays in order to compare the effect on the skin. The cathode-ray intensity was varied by means of a concentration coil (see "Strahlentherapie," 1931, **42,** 1). Clinical and histological studies of the skin reactions showed that they went parallel to the dose applied. The Grenz rays used were produced with a potential of 13.5 K.V. The reaction took an entirely different course as compared with that observed after exposure to cathode rays. This observation is explained by the difference in the absorption of the two types of rays.

ERNST A. POHLE, M.D., Ph.D.

DOSAGE

Relation between X-ray Dosis and Rate of Mutation. K. G. Zimmer. Strahlentherapie, 1934, **51,** 179.

The author compared the experimental results published by a number of authors who have studied the rate of mutation in *Drosophila melanogaster* after irradiation. He found that there is an exact linear relation between dose and rate of mutation.

ERNST A. POHLE, M.D., Ph.D.

HEART AND VASCULAR SYSTEM

Changes of the Cardiac Contour and Size, Produced by Increased Intra-pulmonary Pressure, Investigated Cardio-kymographically. (Cardio-kymograms during the Valsalva Experiments.) F. A. Nolte. Fortschr. a. d. Geb. d. Röntgenstrahlen, September, 1934, **50,** 211–230.

Increase of intra-pulmonary pressure of 10 mm. Hg regularly produces a reduction of the size of the heart of healthy individuals. Only in rare instances is an increase of 35 mm. Hg necessary to produce this effect. This symptom was demonstrated in kymograms obtained in the postero-anterior as well as in the first and second oblique projections.

The reduction involves all cardiac segments simultaneously; an isolated enlargement of any cardiac segment as a result of increased intra-pulmonary pressure could not be demonstrated. The reduction is most marked in the region of the cardiac apex. Cardiac reduction was usually noted immediately during the first systole following the increase of intra-pulmonary pressure. One-third of the cases investigated show a temporary initial enlargement of the heart during the increased pulmonary pressure, which is interpreted as a sudden evacuation of deposits of blood in liver and lungs, resulting from compression of these organs. The maximum reduction of the size of the heart usually is obtained within from three to five seconds following introduction of a pressure of 40 to 70 mm. of mercury. After this initial reduction no further changes could be induced.

Quiescence of the heart never was observed under prolonged pressure, even up to 20 seconds; distinct pulsations of the cardiac margin were observed always, regardless of the duration of the pressure. This is contrary to opinions formed from fluoroscopic observations and graphic registration of pulse curves.

The most rapid reduction in the size of the heart was observed with introduction of very marked pressure differences—20 to 90 mm. of mercury. This was the only relationship noted between the height of the pressure and the type of diminution of the size of the heart. Immediately upon restoration of normal intra-pulmonary pressure blood returns from congested veins to the heart and thus leads to temporary enlargement of it. This enlargement involves all cardiac segments simultaneously. From these experiments it is concluded that apparent changes in cardiac size produced by the Valsalva experiment are to be interpreted as the effects of impaired influx of blood to the right and left cardiac segments.

H. A. JARRE, M.D.

HODGKIN'S DISEASE

Five-year Survival in Hodgkin's Disease. Lloyd F. Craver. Am. Jour. Med. Sci., November, 1934, **188,** 609–612.

Craver reports the results of irradiation in 310 cases of Hodgkin's disease, 125 of which were proved by biopsy. Of the whole number, 10.3 per cent, which includes 16.8 per cent of those biopsied, survived five years. Analysis of the age incidence disclosed that the five-year survivors averaged ten years younger than those surviving less than six months. Histologic studies did not account for these differences, which are ascribed to variations in the virulence of the disease.

Favorable prognostic evidence includes localization of the disease, especially in the upper cervical region, with early surgical and radiologic therapy, a normal leukocytic count, and a gain in weight following irradiation. Fever, marked pruritus, and splenomegaly were unfavorable.

W. A. SODEMAN, M.D.

Irradiation in Lymphosarcoma, Hodgkin's Disease, and Leukemia: Statistical Analysis. T. Leucutia. Am. Jour. Med. Sci., November, 1934, **188,** 612–623.

This report is a statistical analysis of 2,425 cases collected from the literature, as well as 129 cases of the author's own. In all three conditions, lymphosarcoma, Hodgkin's disease, and leukemia, irradiation is the treatment of choice. In lymphosarcoma results are termed "spectacular" with 30 per cent five-year cures and from 10 to 15 per cent ten-year cures. In Hodgkin's disease, 15 to 33 per cent of the patients survive five years. In those dying before five years, life expectancy was increased from two to three and one-half years. Symptomatic relief results as well. In leukemia, the important result of treatment is also symptomatic. The life expectancy is not prolonged but the patient is made more efficient during the course of the disease. Acute forms are not affected.

W. A. SODEMAN, M.D.

RADIATION EFFECTS

Experimental Studies Concerning the Effect of Roentgen Rays on Yeast Fermentation. V. Gronchi. Strahlentherapie, 1934, **51,** 319.

The effect of roentgen rays on the fermentation of *Saccharomyces cerevisiæ* in the presence of glucose was studied. If roentgen rays of a wave length of 0.37 Å. and 0.16 Å. in doses of from 600 to 1,800 r were used, there resulted a definite functional stimulative effect, manifested by an acceleration of the CO_2 production. It appeared that the stimulative effect is proportional to the intensity of the irradiation—it seemed somewhat larger with hard rays than with soft rays.

ERNST A. POHLE, M.D., Ph.D.

RADIUM

Radium Therapy of Cancer of the Palatine Tonsil and the Pillars. Angelo Santoro d'Emidio. Arch. di radiol., 1934, **10**, 208–224.

The author points out the great advantages of interstitial radiation in treatment of cancers in the region of the tonsillar ring and describes in detail his own technic of treatment of these lesions. By it he obtained excellent results and he feels that by it the great danger of hemorrhage is minimized. He does not think that external radiation alone will clear up the majority of these lesions, but may cause them to regress for a considerable length of time. A combination of external radiation by means of moulded applicators with buried tubes of radium leads to the best results, not only with regard to the primary lesion but also to its lymphatic metastases.

E. T. LEDDY, M.D.

A Cytologic Study of the Living Body Irradiated with a Hard Ray. Part I, Influence of a Hard Ray upon the Development of Beans and the Abnormality of the Nuclei and Cell Division. T. Saito. Japanese Jour. Obst. and Gynec., August, 1934, **17**, 285–290. 20 plates.

Saito has studied the influence of radium upon the development of bean roots to note the effect of irradiation upon cells free from the influence of blood supply, congestion, endocrine factors, immune processes, etc., as would prevail in the human body. Results show inhibition of cell development, with abnormalities in cell and nuclear division. First the cytoplasm swells, followed by coagulation and loss of function, changes interpreted as first physico-chemical, then disturbed metabolism, and later extinction of cells.

W. A. SODEMAN, M.D.

The Problem of Radium Dosimetry. W. Friedrich. Strahlentherapie, 1934, **51**, 7.

During the last years numerous investigators have made an attempt to determine radium doses in r; there is, however, a discrepancy in the results obtained. The author and his co-workers have studied this problem in great detail, therefore, and describe two types of apparatus which are suitable for standardization of radium doses in r. One can be brought as close as 2 cm. to the radio-active substance, while the second type, using an amplifier and a very small ionization chamber, is suitable for measuring isodose curves in close proximity to the radium applicator. The construction of the small chamber is described; the measurements show that the filtration of the radio-active substance influences greatly the number of r delivered per mg-hr. at 1 cm. distance. The secondary radiation emitted by the filter was also studied; it further appeared that even distribution of the radium salt within an applicator is of great importance.

Additional measurements were made in order to compare the results obtained by ionization instruments with those obtained by Holthusen and his co-workers with the photographic method. While a satisfactory agreement exists in certain points, there is definite discrepancy in, for instance, the doses in the depth. It appears that for a filter of 0.3 mm. Pt, the dose is 11.2 r in 1 cm. distance for 1 mg. radium.

ERNST A. POHLE, M.D., Ph.D.

Use of Radium in Carcinoma of the Bladder. A. J. D. Smith. British Med. Jour., Sept. 29, 1934, **2**, 584.

Smith points out the wide divergence of opinion as to the use of surgery and radiation in the treatment of carcinoma of the bladder, and believes that the surgical inaccessibility of the majority of cases when first seen suggests a field for radium, as in cancer of the cervix. He prefers the use of radon seeds, applied suprapubically or cystoscopically, as the case demands.

Results are comparable to Barringer's in this country. They show that papillary carcinoma is sensitive to radium and amenable to such treatment when not too extensive and when the growth is confined to the bladder. The infiltrating type is more radioresistant and operative cases of this type should, he believes, be treated by resection. Great care must be taken in the selection of inoperable cases suitable for radium treatment. The extravesical spread of these cases may require widespread interstitial irradiation, which may make the patient more miserable than he was before.

Experience with 60 cases shows that cystoscopic implantation of seeds should be limited to those cases of papillary carcinoma in which the growths are not more than 2 to 3 cm. in diameter. Larger growths should be treated suprapubically.

W. A. SODEMAN, M.D.

Complications Following Radium Therapy of Tumors of the Bladder and Neighboring Organs. W. I. Korchow. Strahlentherapie, 1934, **51**, 164.

The author noticed a series of complications in patients with carcinoma of the prostate and uterine cervix, particularly after sectio alta. He found that the cystitis which existed before operation or irradiation was a principal cause for the necrosis developing later. A few photomicrograms are shown with the article demonstrating the marked changes found in the bladder wall. Before subjecting this type of patient to irradiation, the author urges that a careful study of the rectum as well as the entire uropoietic system be undertaken.

ERNST A. POHLE, M.D., Ph.D.

The Field of Application for Radium. R. Stewart-Harrison. Strahlentherapie, 1934, **51**, 57.

At the Roentgen Institute of the University of Zurich, 98 radium applications were made during 1929–33. In 14 cases radium alone was used as the primary method of treatment; in eight cases it was applied after initial treatment in another clinic. Seventy-six patients received combined treatment with x-rays and radium, 49 of the latter group had carcinoma of the esophagus. The radium applicators, including the technic used, are

described in detail. A number of case reports are appended, with data on dose, technic, and end-results.

A critical analysis of the entire clinical material leads the author to the conclusion that carcinomas of the skin, lip, tongue, and uterus are most suitable for radium therapy. It may also be used, particularly in the interstitial form, for the removal of residual tumors treated first by x-rays. The painful and slow-healing ulcers occurring sometimes after implantation of radium needles may be benefited by short wave diathermy.

ERNST A. POHLE, M.D., Ph.D.

SELLA TURCICA

The Detailed Anatomy of the Sella Turcica and its Clinical Significance for the Recognition of the Size of the Hypophysis; A Contribution to the Study of the Relationship of the Size of the Hypophysis and the Size and Form of the Sella Turcica to Anatomic and Functional Hypogenitalism. O. Bokelmann. Fortschr. a. d. Geb. d. Röntgenstrahlen, April, 1934, **49,** 364–396.

There is no direct relationship between the size (capacity) of the pituitary fossa and the size (weight and volume) of the related pituitary body. A decidedly small pituitary body may often be situated in a small pituitary fossa but a large pituitary body not uncommonly occurs in a medium or small pituitary fossa. This statement, therefore, implies that various determinations of the size of the pituitary fossa under physiologic conditions permit of but very approximate, inaccurate conclusions as to the size of this appendage of the brain.

This study has shown certain direct relationships between the size (weight and volume) of the pituitary body and the size of the anteroposterior median profile of the pituitary fossa, which under physiologic conditions permit of the following useful clinical conclusions:

(*a*) A small pituitary fossa in females always contains a small pituitary body, but in males it may contain either a small or a medium sized pituitary body.

(*b*) A definitely small median pituitary fossa profile corresponds in 60 per cent of all cases to a small pituitary body; sometimes it may correspond to a medium but never to a large pituitary body.

(*c*) A definitely large median pituitary fossa profile usually corresponds to a large pituitary body, occasionally, however, to a medium sized, never to a small pituitary body.

(*d*) Medium sized pituitary fossa profiles are observed in various types of pituitary body sizes.

Determinations of the actual size of the pituitary body from the size of the pituitary fossa profile become increasingly incorrect with advancing age, especially above approximately 56 years.

The size of the lateral sella turcica profile cannot be used at all for a determination of the size of the hypophysis. All conclusions reported above are drawn from the profile of the sella in the correct median plane.

An estimation of the size of the hypophysis as judged by the size of the median profile of the sella is permissible only if median and lateral profiles of the sella either can be differentiated clearly or may be recognized as with certainty coinciding. An exception may only be granted in cases of so-called bridge-formation between the clinoid processes; in such instances the hypophyses usually are small, even in case the median profile of the sella is fairly large.

Formation of bridges between the clinoid processes is seen unusually often in individuals who suffer from some kind of dysfunction of the genital system or have hypogenitalism. (Of all adults with such functional disorder, 50 per cent show such bridging.)

The average weight and volume of hypophyses show increasing fluctuation with increasing age.

The average weight of the hypophysis is higher in females than in males, regardless of age.

About 50 per cent of all females and from 50 to 60 per cent of all males with small hypophyseal weight—below average—show symptoms of developmental or functional hypogenitalism.

H. A. JARRE, M.D.

SKIN (GENERAL)

Spectrophotometric Studies on Human Skin with Special Consideration of the Determination of the Degree of Erythema and Pigmentation. H. G. Bode. Strahlentherapie, 1934, **51,** 81.

The author reports in detail his studies concerning the exact measurements of erythema and pigmentation of the human skin following irradiation. The spectrophotometric method is the most accurate way to obtain reproducible results. A series of curves show the behavior of normal human skin as compared with skin showing erythema or pigmentation.

ERNST A. POHLE, M.D., Ph.D.

"Sieve" Radiation. W. Haring. Strahlentherapie, 1934, **51,** 154.

The author studied the skin reaction following x-ray exposure through a lead plate 3 mm. thick with holes of 3 mm. diameter. It appeared that he could give three times the dose as compared with the skin tolerance without the lead plate. He investigated the distribution of the radiation in a water phantom by placing films in a horizontal position at 2, 4, 6, 8, and 10 cm. depth. The films showed that the rays continue as "needles" throughout the water and do not unite; in other words, they show the pattern of the "sieve."

ERNST A. POHLE, M.D., Ph.D.

Melanotic Neoplasms of the Skin. S. William Becker. Am. Jour. Cancer, September, 1934, **22,** 17–40.

Becker points out that the advent of new methods of study, especially the silver method, which causes a darkening of pre-existing melanin and the "dopa" reaction, which demonstrates pigment-forming cells, has revolutionized the study of pigmentation. He has found the dendritic type of cell described by Maximow at or near the epidermo-dermal junction in all pig-

mented epithelium, and cites the belief of Masson that these specialized cells, which transfer preformed pigment to the palisade basal cells, are the only pigment-producing cells. These pigment-forming cells are called "melanoblasts" and an increase in their number results in a smooth brown nevus. The cells forming elevated nevi are thought to be derived from the same source. When located deeply in the dermis a blue nevus or Mongolian spot results. The source of melanoblasts, although not known, is thought to be nervous.

Irradiation by ultra-violet or alpha rays causes a prominence and branching of melanoblasts followed by hyperpigmentation of palisade basal cells. "Lentigo" is a lesion resulting in the same histologic picture from no demonstrable cause. With pigment activity progressing to a point at which melanoblastic proliferation occurs, the lesion is called "lentigo maligna." Further activity produces melanoma, which arises from the melanoblastic cells at the epidermo-dermal junction and not in deep-lying nevus cells. Many cutaneous carcinomas contain melanin due to the presence of normal-appearing melanoblasts.

W. A. SODEMAN, M.D.

THE SPINE

The Clinical Importance of the Intervertebral Discs, with Special Reference to Nuclear Prolapses. Gilbert B. Bush. Bristol Medico-chi. Jour., 1934, **51,** 173–182.

Bush draws our attention to a study of the intervertebral discs as a site of important spinal disease. The anatomy of the normal disc is discussed, with a description of the fibro-cartilaginous annular portion containing the nucleus pulposus in its center. The nucleus pulposus, containing fluid under pressure, is placed between the epiphyseal end plates of the vertebral bodies to act as a shock-absorber and a sort of roller-bearing on which spinal movements occur. If disease involves the cartilaginous end-plate, seepage of fluid from the nucleus pulposus takes place and elasticity of the disc is lost. Erosion by pressure may occur in the vertebral body, even to the extent that prolapse of the nucleus through a fissure to the bony spongiosa may take place.

These changes, occurring often in young adults, may be manifested clinically by pain in the back and a slight degree of kyphosis. Radiographs may show irregular contour of the upper and lower margins of the vertebral bodies, especially in the lower dorsal region. Wedging of the vertebral bodies and narrowing of the intervertebral spaces may occur. Therapy consists of rest and fixation.

W. A. SODEMAN, M.D.

TUBERCULOSIS, PULMONARY

Tuberculous Lesions in Children of School Age. H. W. Hetherington. Penn. Med. Jour., September, 1934, **37,** 990–992.

The most serious problem to be considered in the study of tuberculous lesions in white children of school age is the diagnosis and treatment of apical tuberculosis in adolescent children. The tuberculous lesions observed between infancy and puberty in whites are usually benign; however, negro children are more susceptible to tuberculosis and are not uncommonly afflicted by the severer forms of tuberculosis which are usually confined to infancy in the white race.

The adult or apical form of tuberculosis found in adolescent children spreads downward from the apical region, causing fibrosis and cavitation. The lymph nodes at the root of the lung are not usually involved in this condition. A fairly long latent period is the rule before the onset of clinical symptoms, and while many of these lesions in the latent stage do not progress into clinical tuberculosis, the importance of diagnosis during this latent period is obvious. During the years from 1927 to 1931, roentgen-ray studies in the high schools of Philadelphia revealed that apical infiltration was present in 2 per cent of adolescent girls and in 1 per cent of adolescent boys.

The usual forms of tuberculous lesions found in the lungs and lymph nodes of white children between the ages of 5 and 12 years are usually benign and their presence, extent, and character can be determined only by roentgen-ray study. The most common type of tuberculous involvement seen in this age group is the caseous or calcified nodule, associated with its lymph node lesion. Another form of tuberculosis seen at this time of life is the diffuse childhood-type infiltration. Roentgen-ray examination shows spots, spots and strands, or strands, either alone or with calcified areas. This form is also accompanied by lymph node disease. The usual end-result in white children is a strand-like infiltration with no more significance than a calcified pulmonary nodule. Those cases which progress into clinical disease must be distinguished from non-tuberculous pulmonary lesions.

J. N. ANÉ, M.D.

Notes on the Interpretation of Chest Radiographs, with Particular Reference to Tuberculosis. T. Garratt Hardman. Irish Jour. Med. Sci., July, 1934, p. 305.

The author begins by stating, "I am inclined to think that an examination of a series of normal cases teaches one almost as much about pulmonary disease as an examination of pathological cases." He discusses some of the normal radiographic chest findings of normal individuals. The radiographic signs which were looked for as evidence of a tuberculous infection were as follows:

(1) Calcareous glands in the hila; (2) Infiltration of the pulmonary parenchyma by multiple, typical nodular foci or a localized Assman's or Ghon's focus; (3) Infiltration by fibrous tissue as evidence of a healing tuberculous process; (4) Isolated calcified nodes in the lung tissues indicating healed foci.

G. E. BURCH, JR., M.D.

Tuberculous and Non-tuberculous Pulmonary Infections in Infancy and Childhood. F. Maurice McPhedran. Penn. Med. Jour., September, 1934, **37,** 985–989.

The mortality rate of tuberculosis in infancy is greatest in the second half of the first year of life, and in the consideration of the control of this disease the prevention of exposure and the early detection of infection are of the greatest importance. Any attendant with suggestive symptoms should have a complete examination, including roentgenograms. The early diagnosis of the disease in infancy is dependent upon the tuberculin reaction, the roentgenogram, and accurate clinical observation.

The tuberculin reaction is of great value in infancy, for not only does it indicate the existence of infection but sometimes serves as an index of the severity of the infection. A positive tuberculin reaction should be followed by roentgen examination to discover if the lesion is large enough to be seen. If the first roentgen examination is negative, it should be repeated at first monthly, and then quarterly, depending upon the condition of the infant. "As long as no lesion can be discovered by this means either in the lungs or lymph nodes the probability of a serious or progressive infection is small." In the author's experience, "evidence is lacking that tuberculous infection of which the sole evidence is a positive tuberculin reaction is sufficient to cause fever or ill health in an infant."

The roentgen lesions of tuberculosis of infancy may be considered as those of the lungs and those of the lymph nodes, but it must be remembered that the latter condition results from the primary infection of the lung. A pulmonary lesion may spread by contiguity or by the bronchi, or, by overwhelming the damaged lymphatic nodes, result in fatal miliary disease or meningitis. Tuberculous bronchopneumonia, appearing as a grouped mottling, is another type of tuberculous infiltration observed in infancy.

In the treatment of the enlarged uncalcified pulmonary lymph node, attention should be directed particularly to the prevention of further burden on the damaged nodes, not only as a result of reinfection but also by other non-tuberculous pulmonary infections. In the treatment of unilateral pulmonary tuberculosis artificial pneumothorax is considered of great value.

The non-tuberculous pulmonary disease of infancy and childhood may be divided into lobar pneumonia, acute bronchopneumonia, and chronic or relapsing bronchopneumonia with or without bronchiectasis. The differentiation of these non-tuberculous pulmonary lesions from tuberculosis depends upon the onset, course, and anatomic distribution.

J. N. ANÉ, M.D.

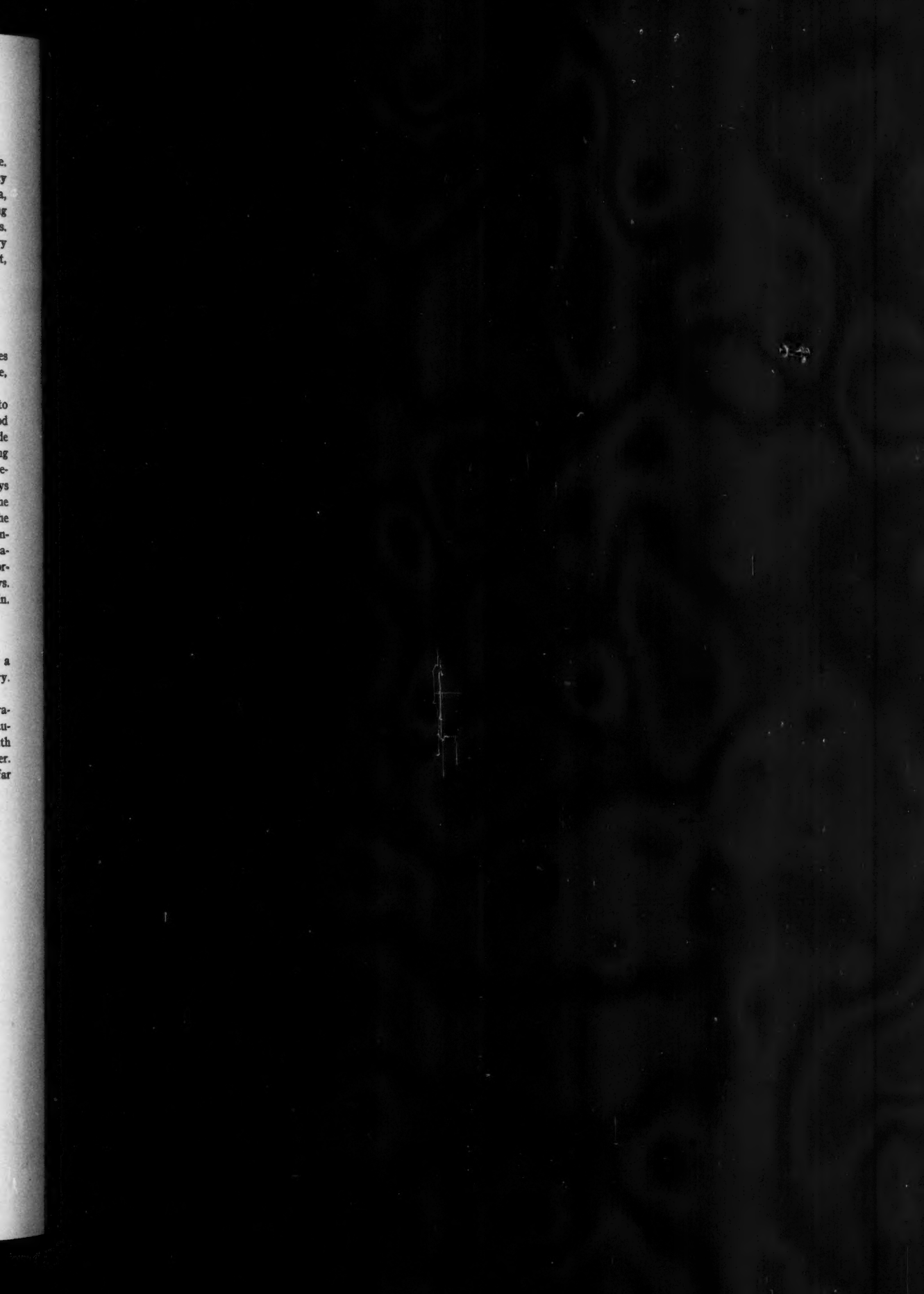
ULTRA-VIOLET LIGHT

The Influence of Sunlight on the Red Blood Corpuscles of Man *in Vivo*. W. W. Lepeschkin. Strahlentherapie, 1934, **51**, 339.

Red blood corpuscles *in vivo* respond to exposure to visible or ultra-violet light in a manner similar to blood corpuscles suspended in a physiological sodium chloride solution *in vitro*. Provided there is a sufficiently long exposure *in vivo*, there is always a lowering of the resistance of the blood corpuscles. The ultra-violet rays of the sun do not penetrate in sufficient quantity in the living organism to affect the red blood corpuscles in the same manner—on the contrary, there results an increase in the resistance. It almost seems as if the ultra-violet rays of the sun were protecting the red blood corpuscles against the injurious effect of the visible rays. This holds true, however, only for non-pigmented skin.

ERNST A. POHLE, M.D., Ph.D.

The Usefulness of the Decomposition of H_2O_2 as a Measuring Reaction in Ultra-violet Light Dosimetry. H. Sostmann. Strahlentherapie, 1934, **51**, 359.

Koeppe has developed a measuring method for ultra-violet rays using the decomposition of H_2O_2. The author compares the results obtained by that method with those given by the iodine test of Bering-Meyer-Keller. He comes to the conclusion that the iodine test is far more reliable than the H_2O_2 test.

ERNST A. POHLE, M.D., Ph.D.